US010766571B2

(12) **United States Patent**
Sampson et al.

(10) **Patent No.: US 10,766,571 B2**
(45) **Date of Patent: Sep. 8, 2020**

(54) **SNOWMOBILE**

(71) Applicant: **Polaris Industries Inc.**, Medina, MN (US)

(72) Inventors: **Martin E. Sampson**, Roseau, MN (US); **Lyle J. Dahlgren**, Roseau, MN (US); **Jerry A. Olson**, Roseau, MN (US)

(73) Assignee: **Polaris Industries Inc.**, Medina, MN (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 530 days.

(21) Appl. No.: **14/849,361**

(22) Filed: **Sep. 9, 2015**

(65) **Prior Publication Data**

US 2015/0375826 A1 Dec. 31, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/773,326, filed on Feb. 21, 2013, now abandoned, which is a continuation of application No. 12/782,363, filed on May 18, 2010, now Pat. No. 8,381,857, which is a continuation-in-part of application No. 11/501,456, filed on Aug. 9, 2006, now abandoned.

(51) **Int. Cl.**

B62J 25/00	(2020.01)
B62M 27/02	(2006.01)
B60N 3/06	(2006.01)
B62M 27/00	(2006.01)
B60K 11/04	(2006.01)

(52) **U.S. Cl.**

CPC ***B62M 27/02*** (2013.01); ***B60K 11/04*** (2013.01); ***B62M 27/00*** (2013.01); *B62M 2027/027* (2013.01); *B62M 2027/028* (2013.01)

(58) **Field of Classification Search**

CPC ... B60N 3/06; B62M 2027/028; B62M 27/00; B62M 27/02; B62J 25/00

USPC 180/9.25, 182, 186, 190, 90.6; 296/75

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,613,205	A *	10/1971	Takada	B62B 17/06 180/190
3,804,455	A *	4/1974	Gorski	B62D 37/06 180/182
3,840,083	A *	10/1974	Woods	B62B 17/00 180/190
3,981,373	A *	9/1976	Irvine	B62M 27/02 180/190
6,682,085	B2 *	1/2004	Furuhashi	B60R 3/002 182/150
6,758,497	B2 *	7/2004	Bergman	B62J 35/00 180/183
6,772,852	B2 *	8/2004	Morin	B62M 27/00 180/182

(Continued)

FOREIGN PATENT DOCUMENTS

CA	2400127	*	8/2003

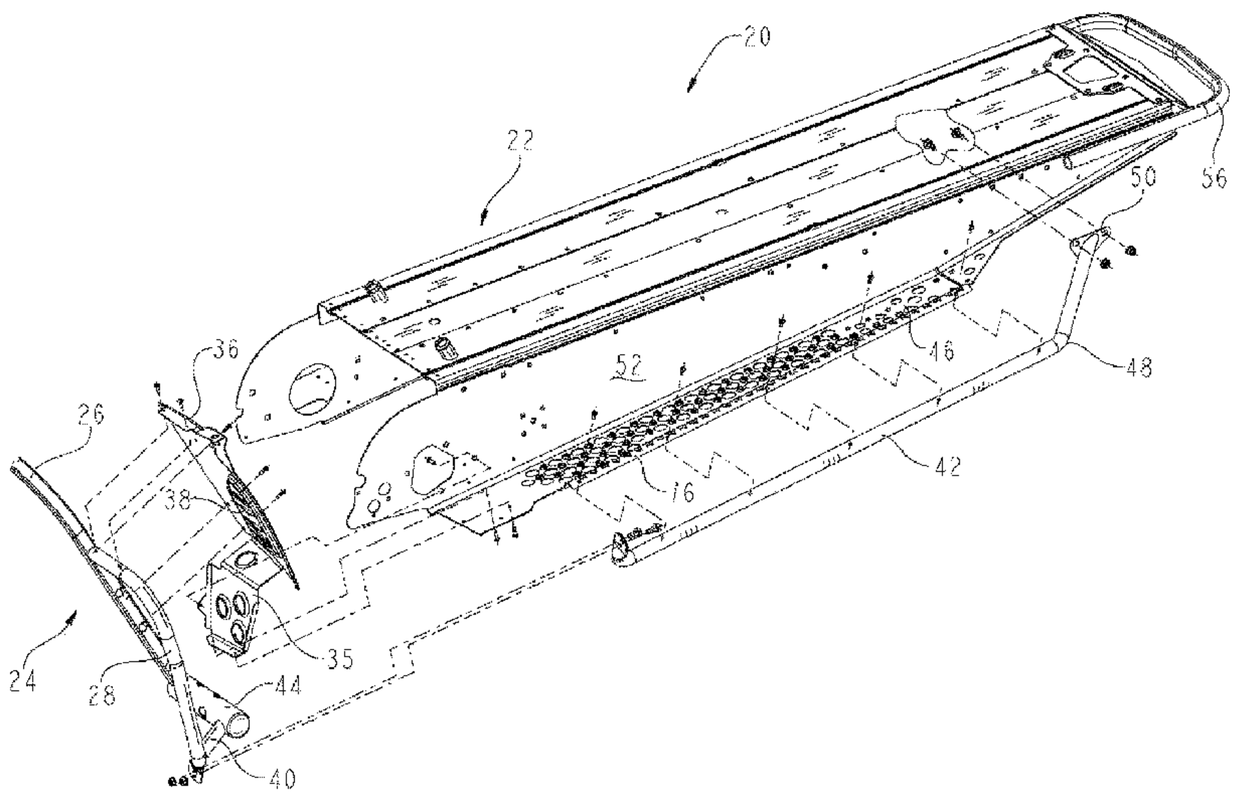
Primary Examiner — Anne Marie M Boehler

(74) *Attorney, Agent, or Firm* — Faegre Drinker Biddle & Reath LLP

(57) **ABSTRACT**

A snowmobile includes a frame having side walls and a support platform. The side walls cooperate with the support platform to define a tunnel. The snowmobile further includes an endless belt assembly supported by the frame, a motor supported by the frame, and a running board removably coupled to the tunnel.

17 Claims, 33 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

7,080,706	B2 *	7/2006	Vaisanen	B62J 25/00 180/190
7,150,336	B2 *	12/2006	Desmarais	B62M 27/02 180/190
7,607,673	B1 *	10/2009	Vey	B60R 3/002 180/210
7,997,372	B2 *	8/2011	Maltais	B62M 27/02 180/190
8,733,773	B2	5/2014	Sampson	
8,919,477	B2	12/2014	Conn	
8,944,204	B2	2/2015	Ripley	
9,352,802	B2	5/2016	Sampson	
2003/0070854	A1 *	4/2003	Bergman	B62M 27/02 180/182
2003/0150658	A1 *	8/2003	Nakano	B62M 27/02 180/190
2005/0126839	A1 *	6/2005	Rasidescu	B62M 27/02 180/190
2006/0032700	A1 *	2/2006	Vizanko	F02M 35/162 181/266
2013/0032420	A1	2/2013	Mills	

* cited by examiner

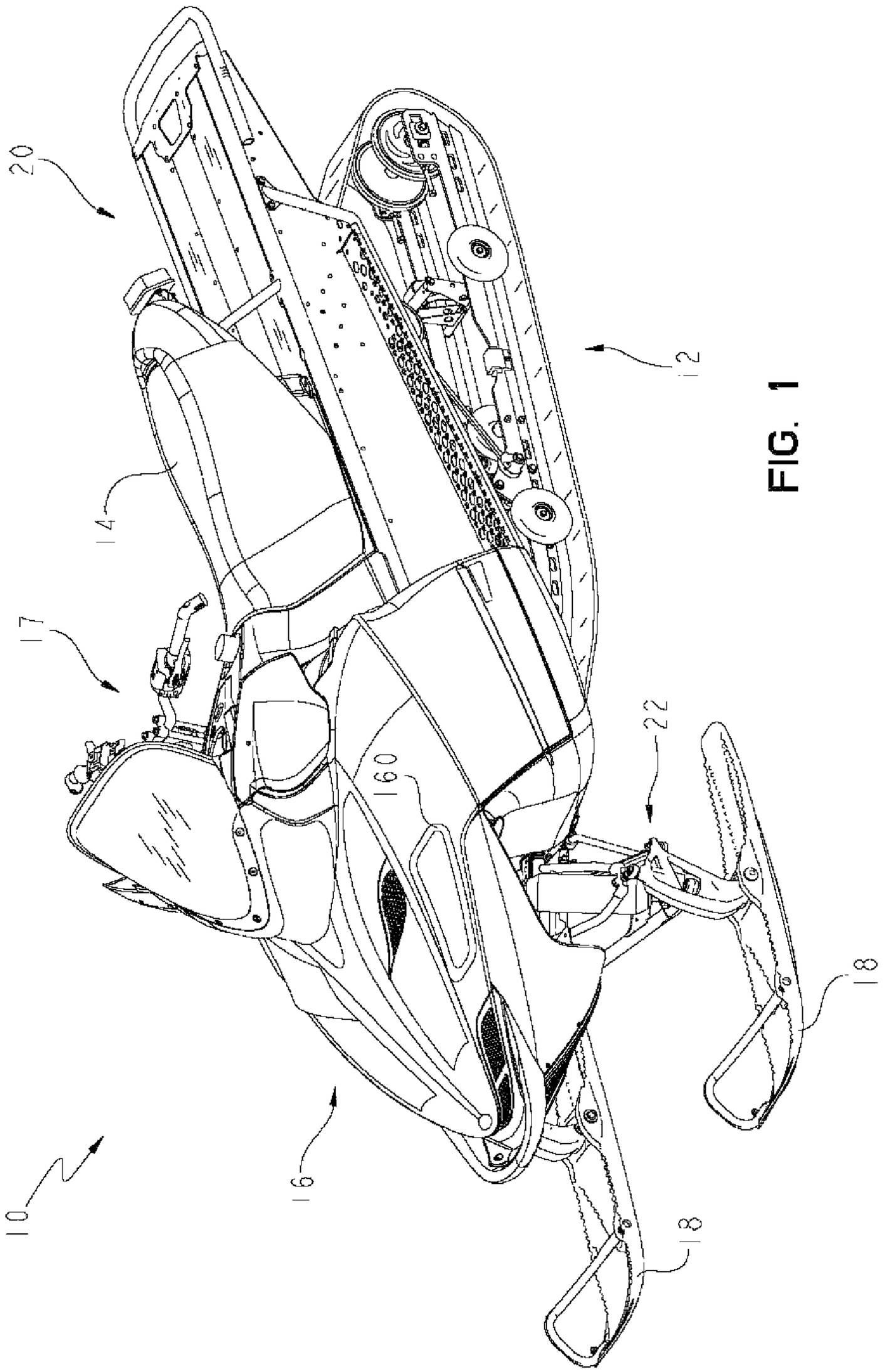


FIG. 1

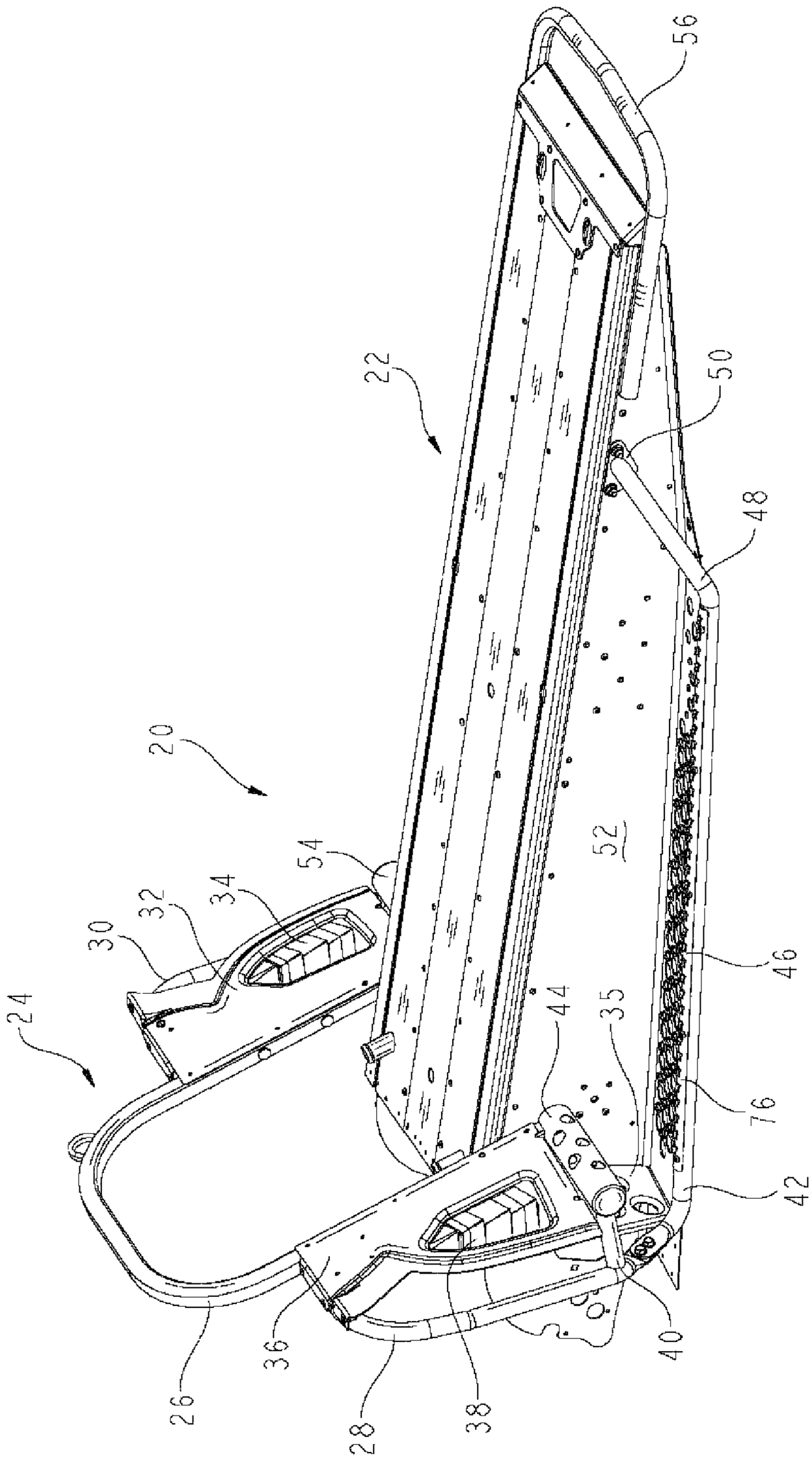


FIG. 2

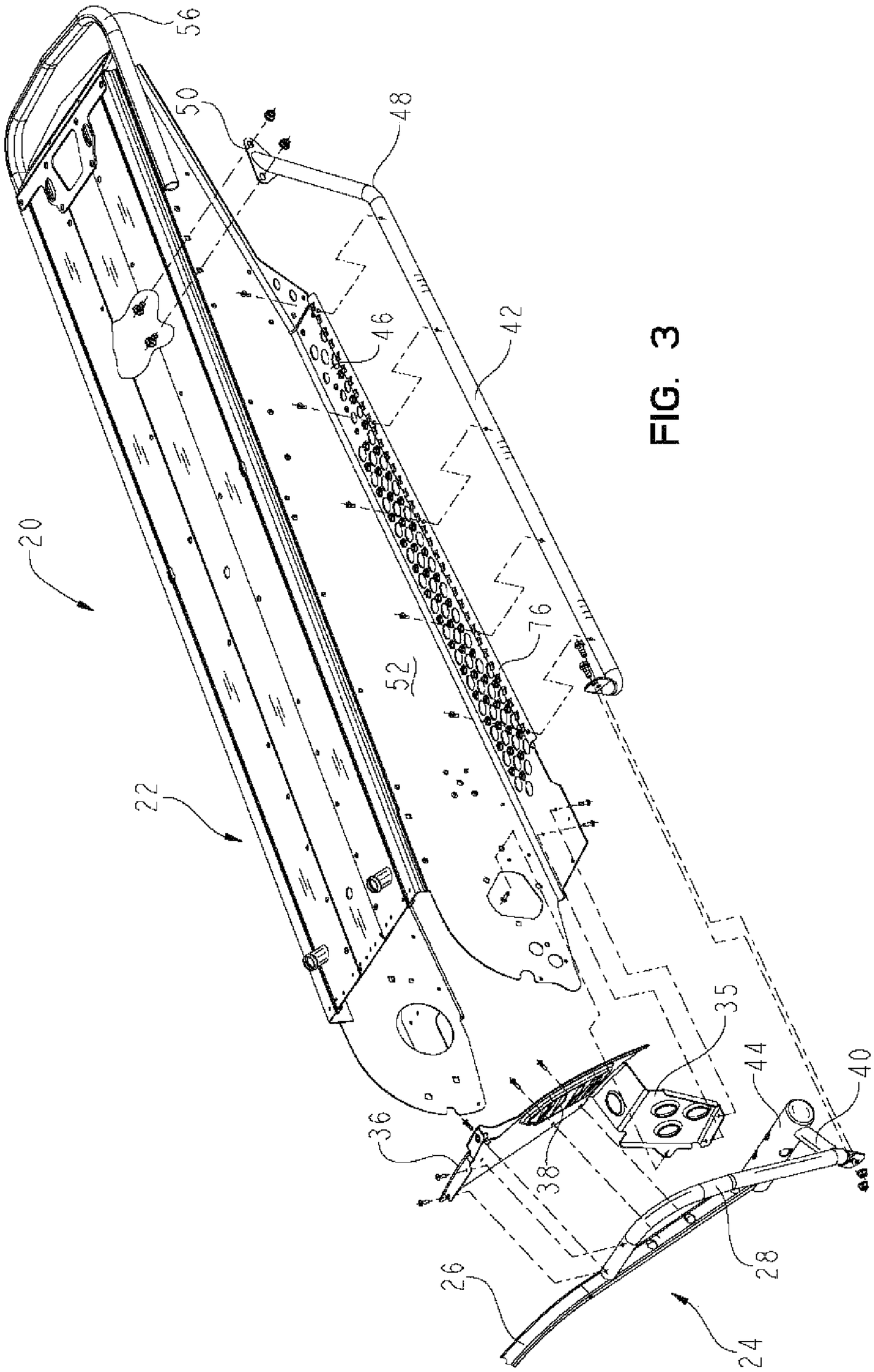


FIG. 3

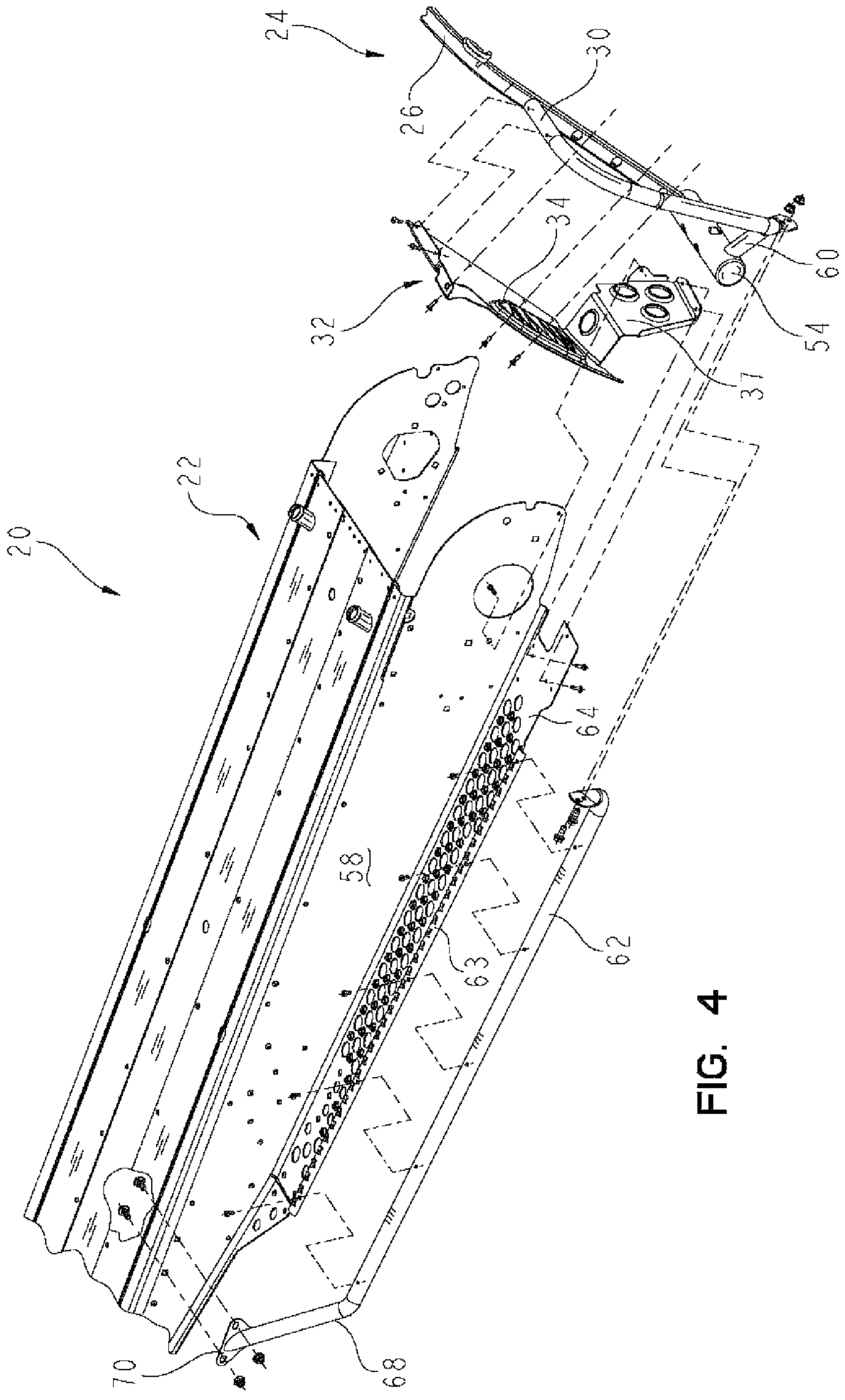


FIG. 4

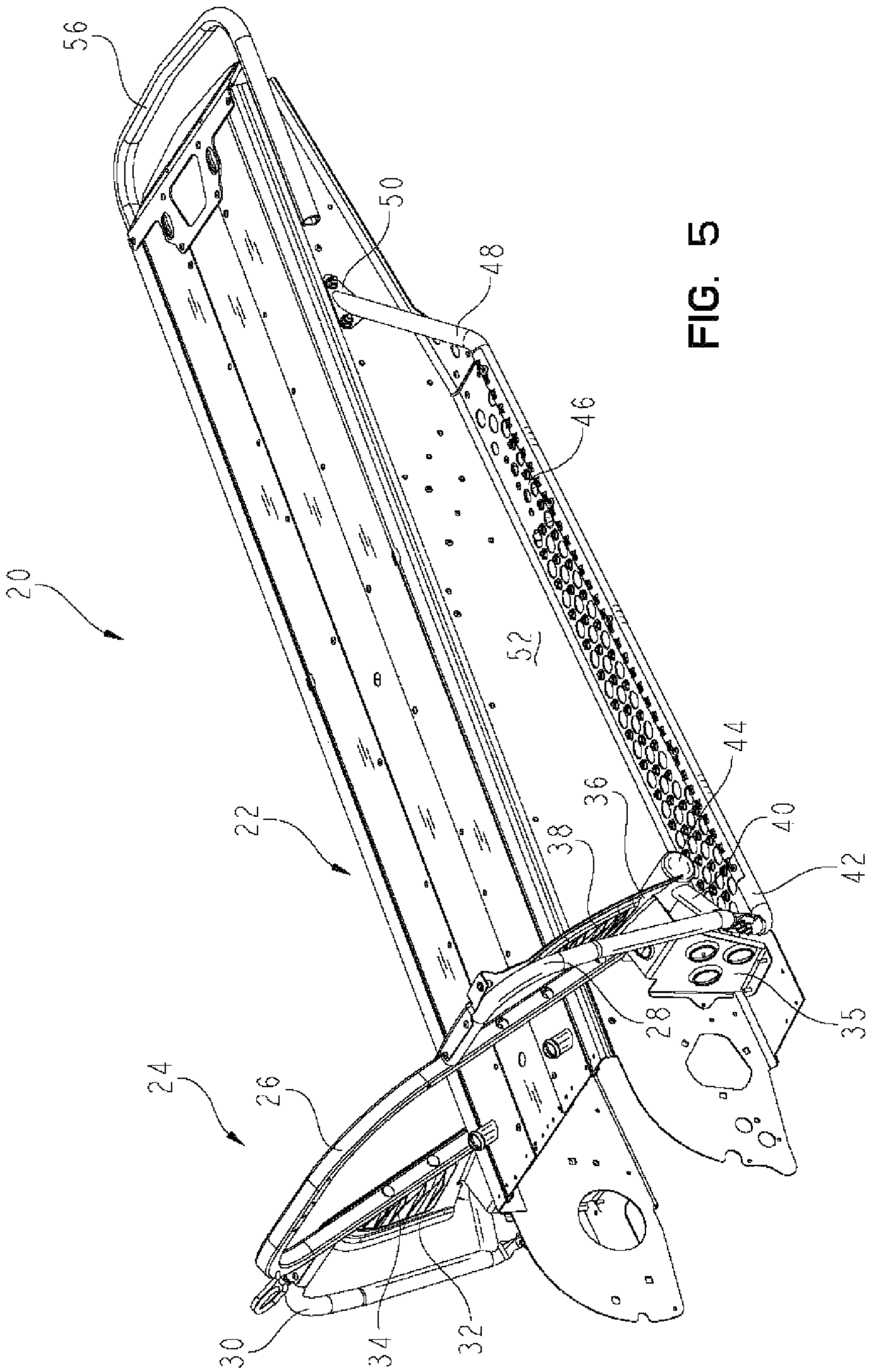


FIG. 5

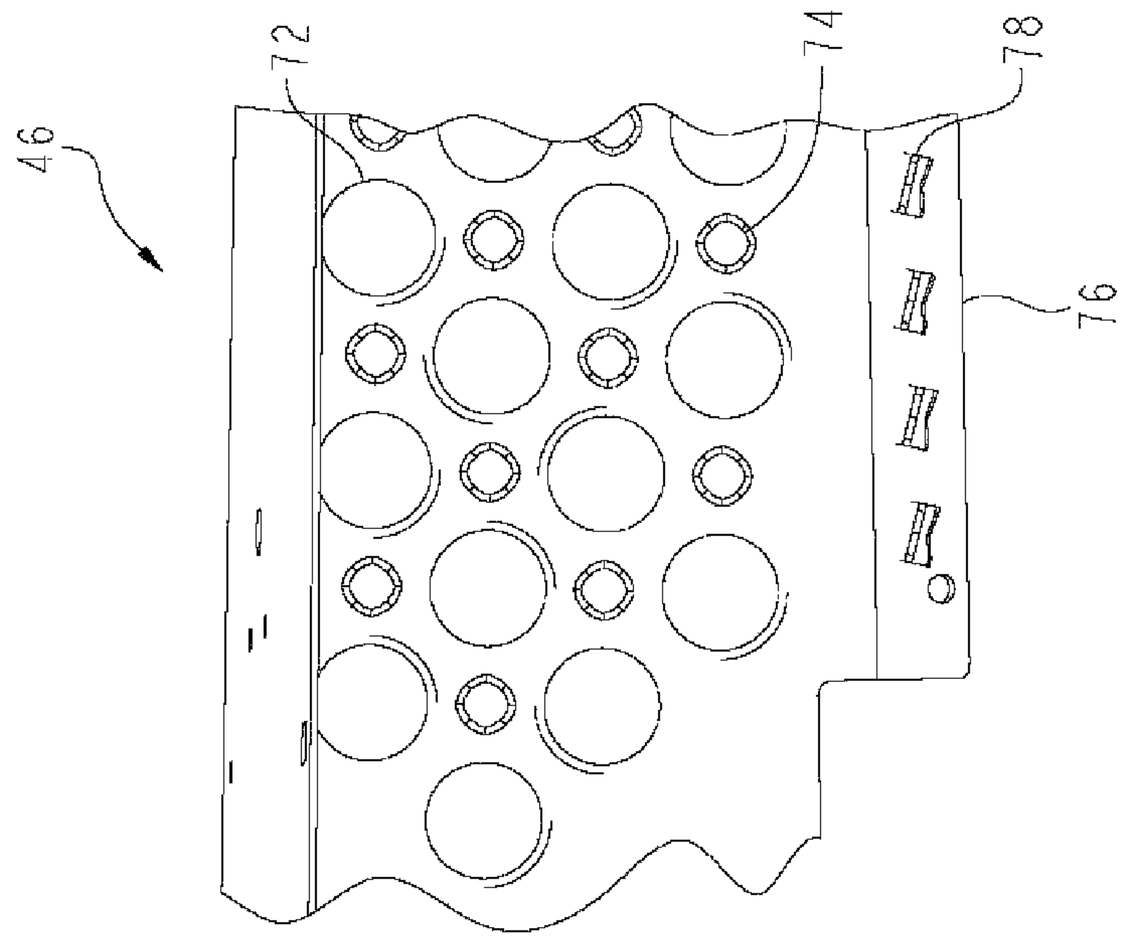


FIG. 6

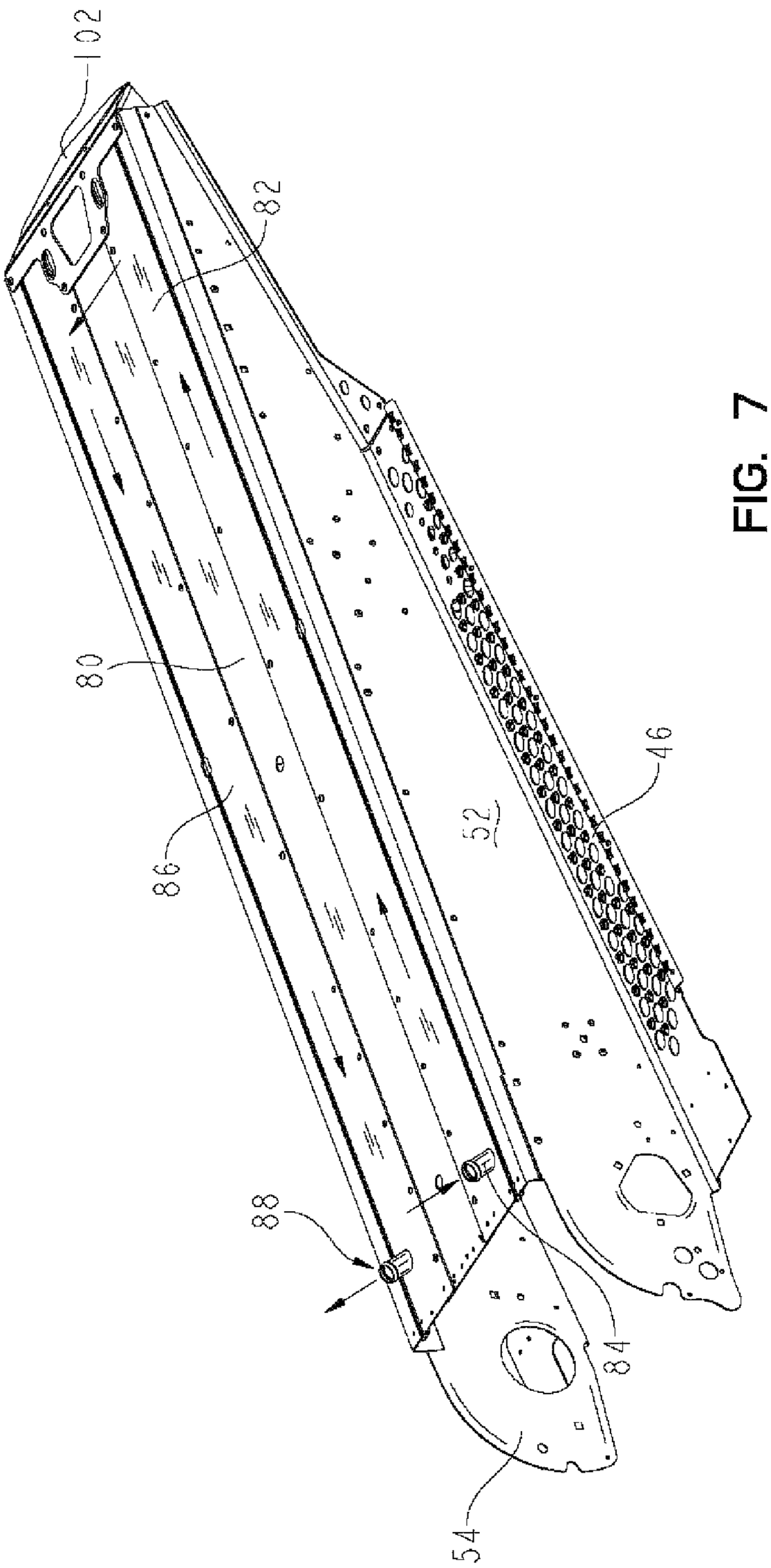


FIG. 7

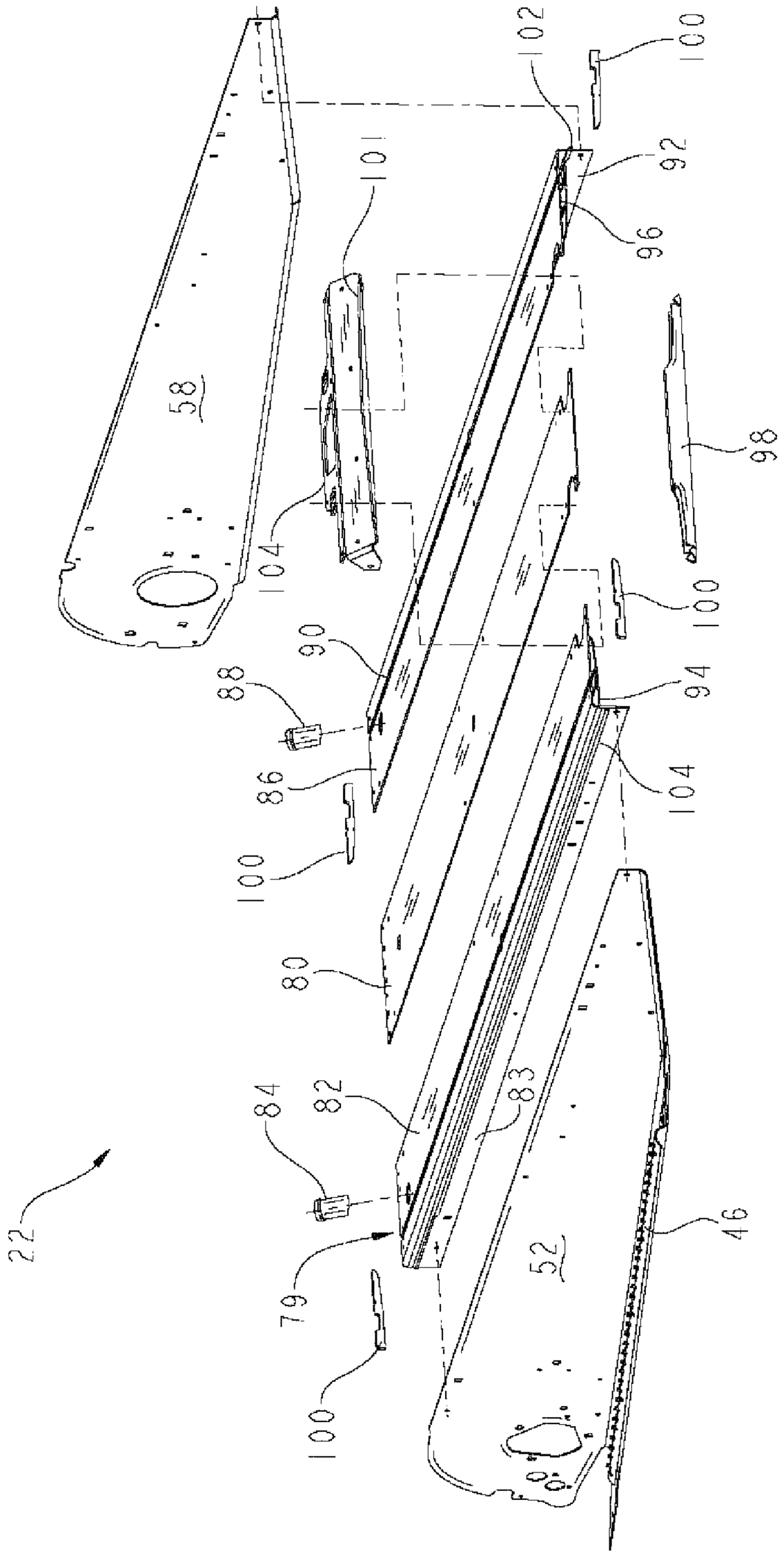

102
100
101
92
96
58
98
104
90
100
88
94
86
104
100
80
84
82
83
79
52
46
100
22

FIG. 8

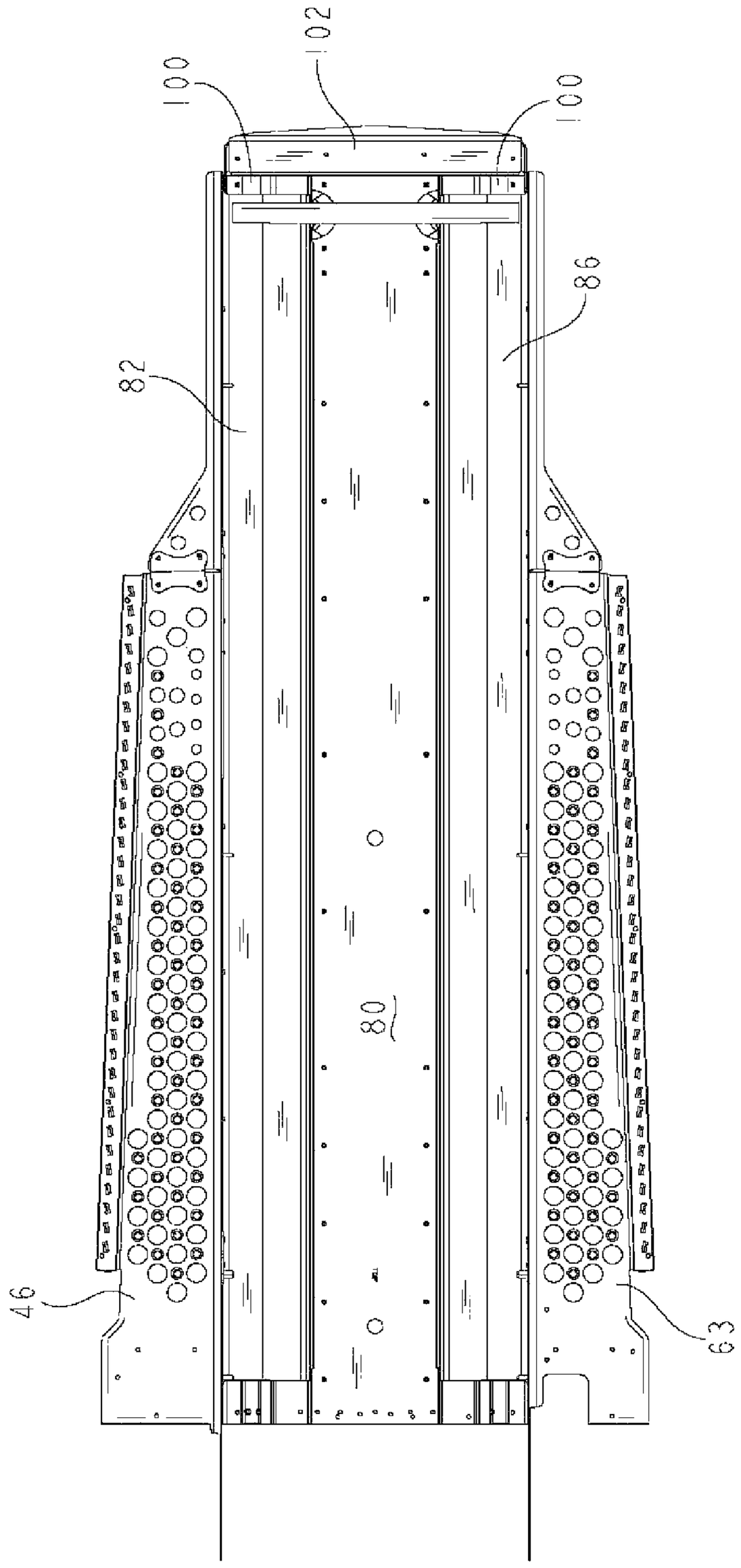


FIG. 9

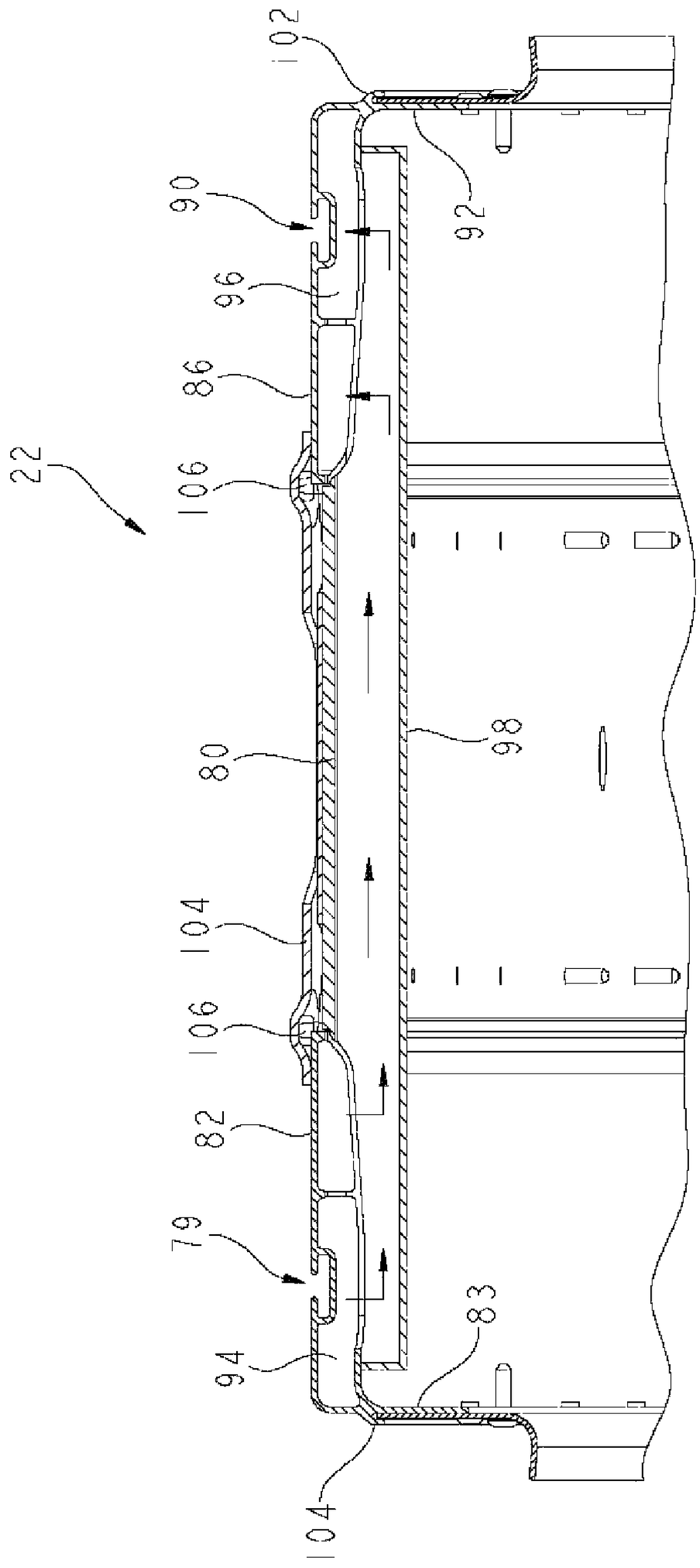


FIG. 10

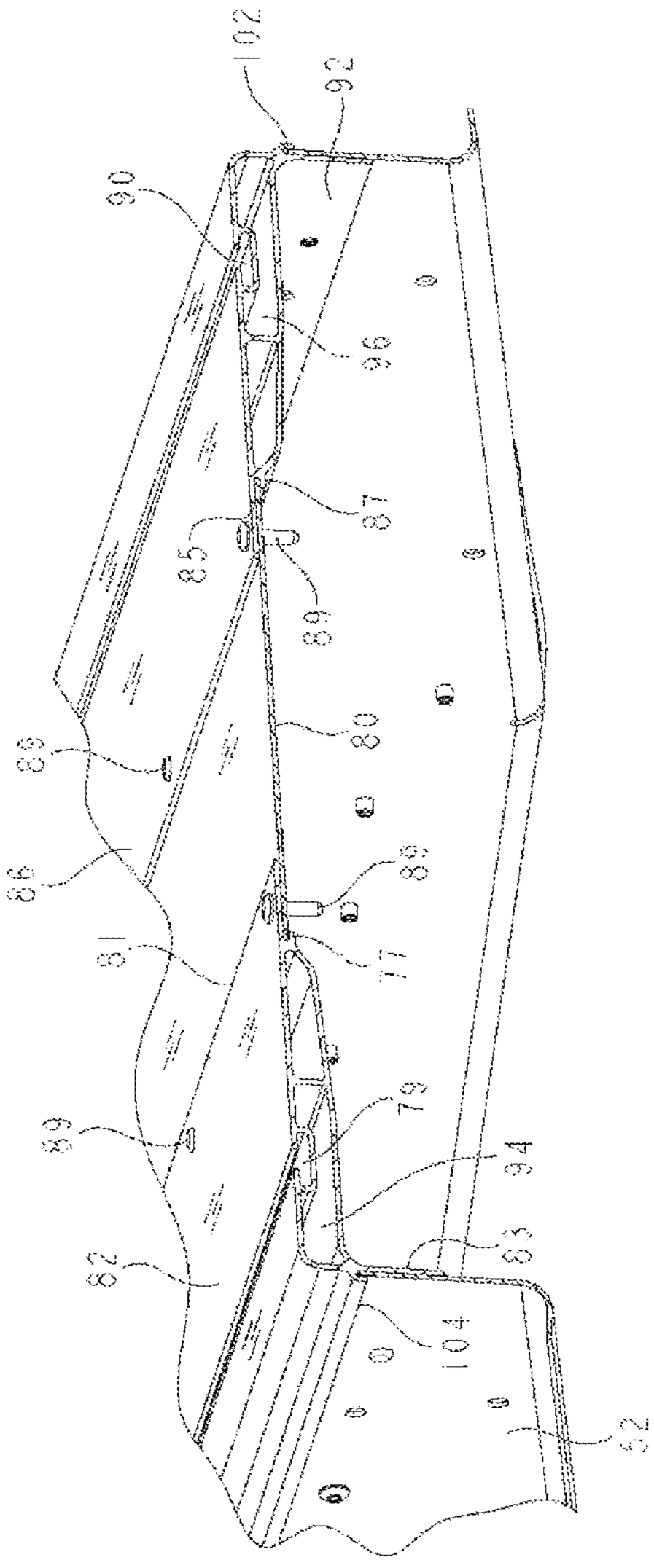


FIG. 11

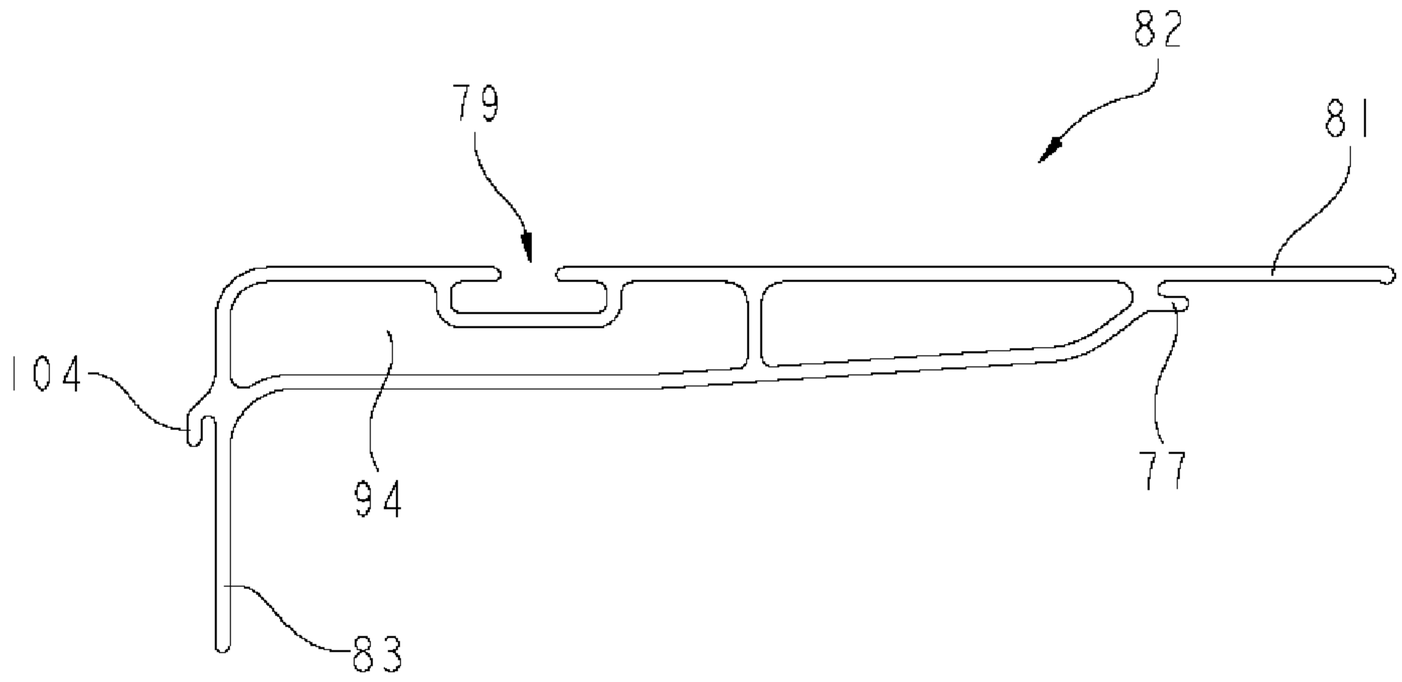


FIG. 12

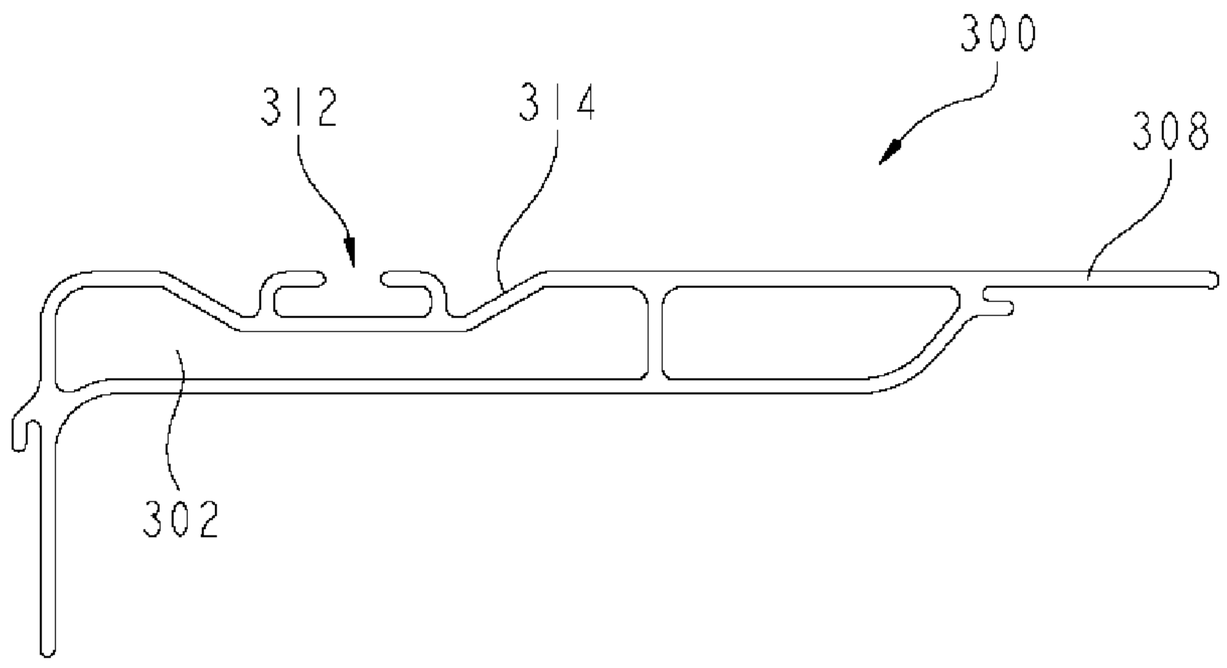


FIG. 13

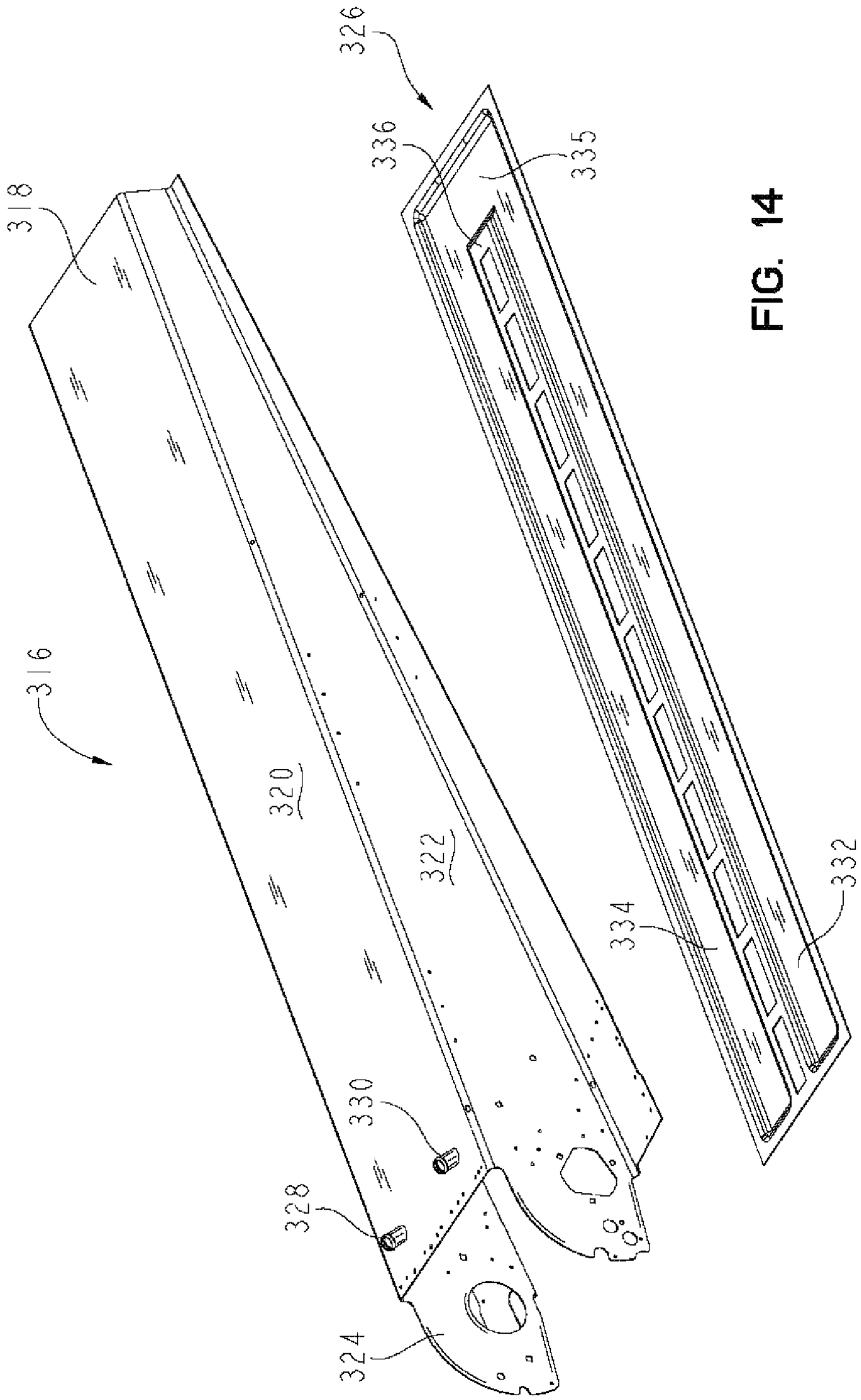


FIG. 14

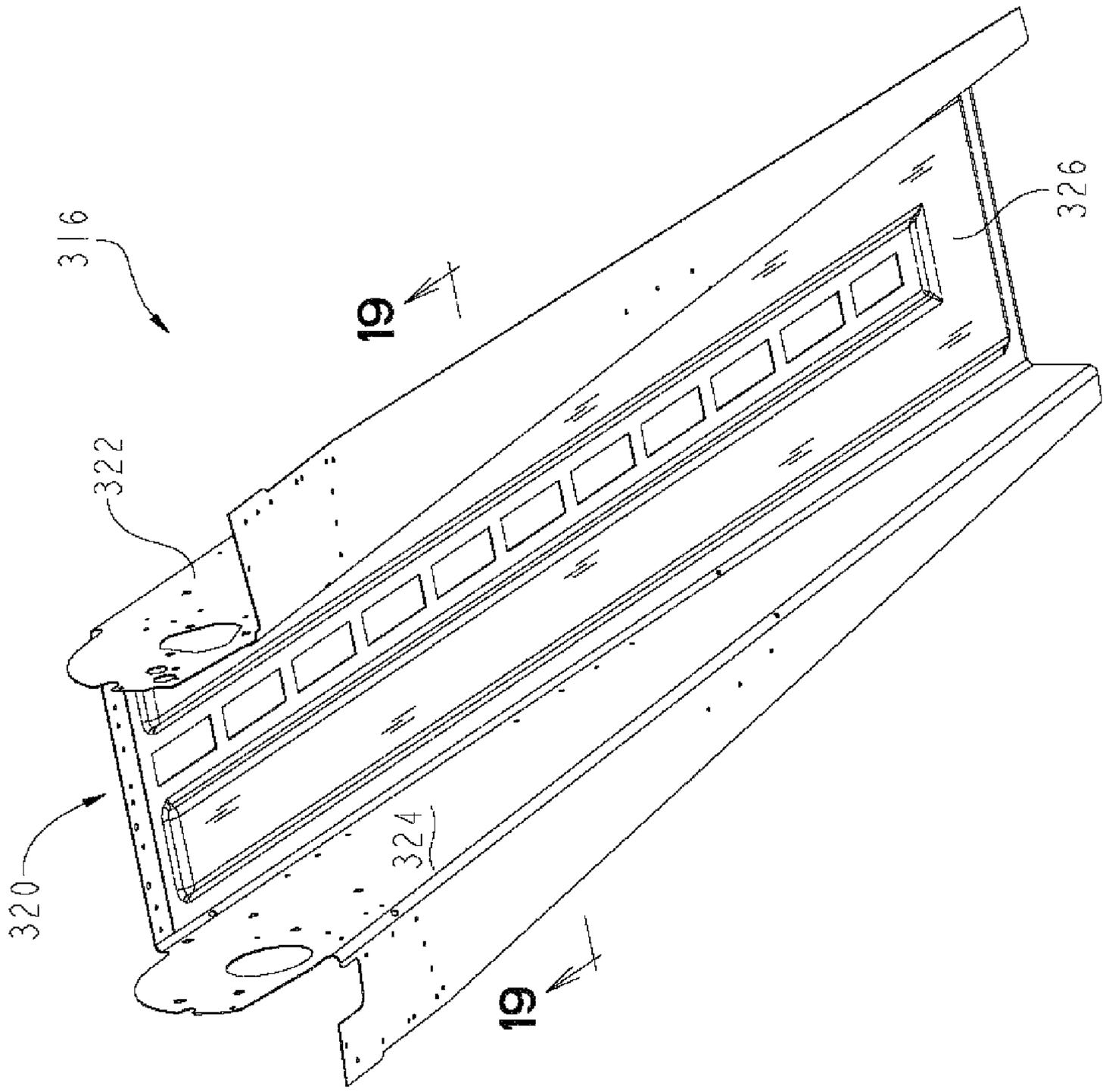


FIG. 15

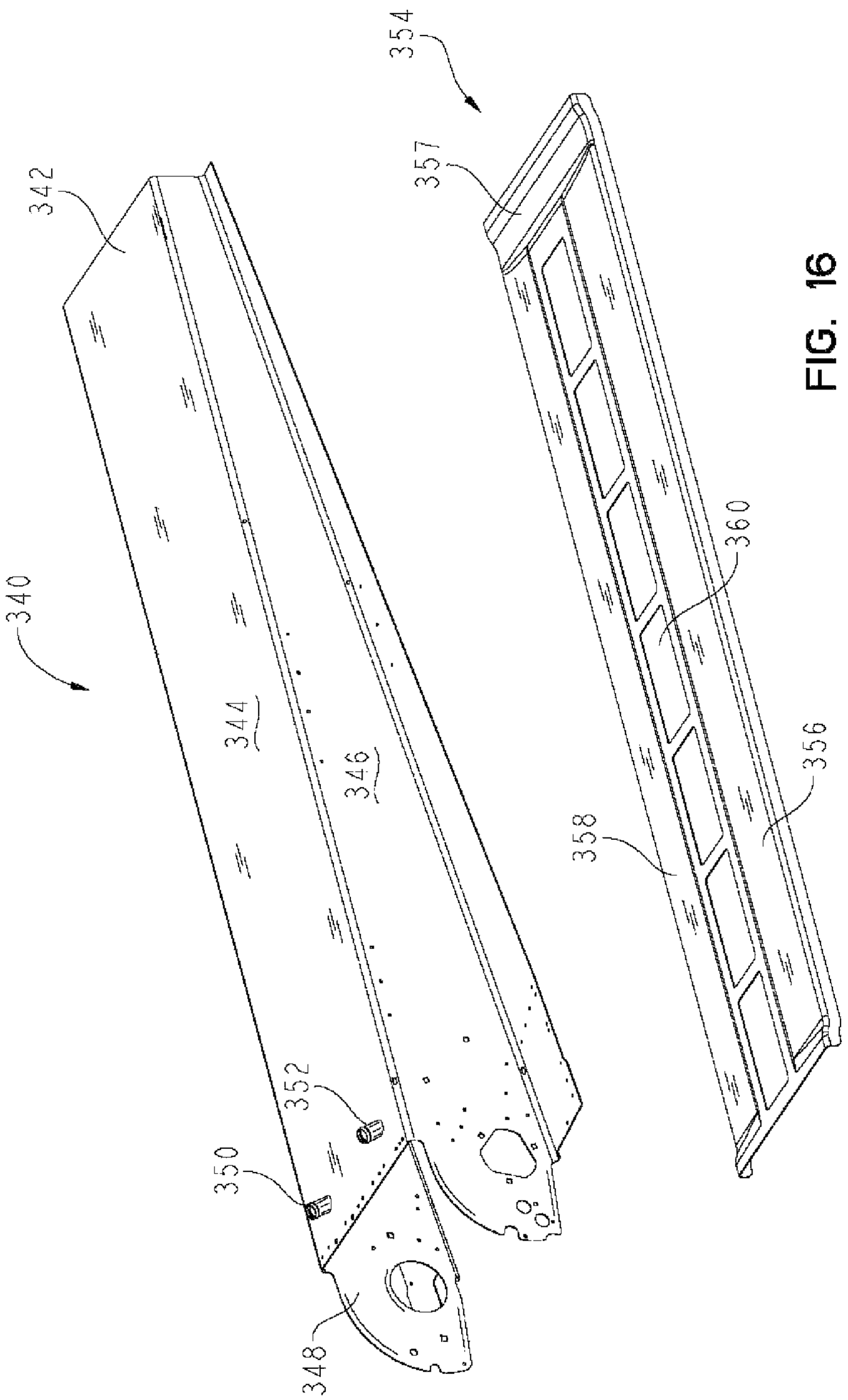


FIG. 16

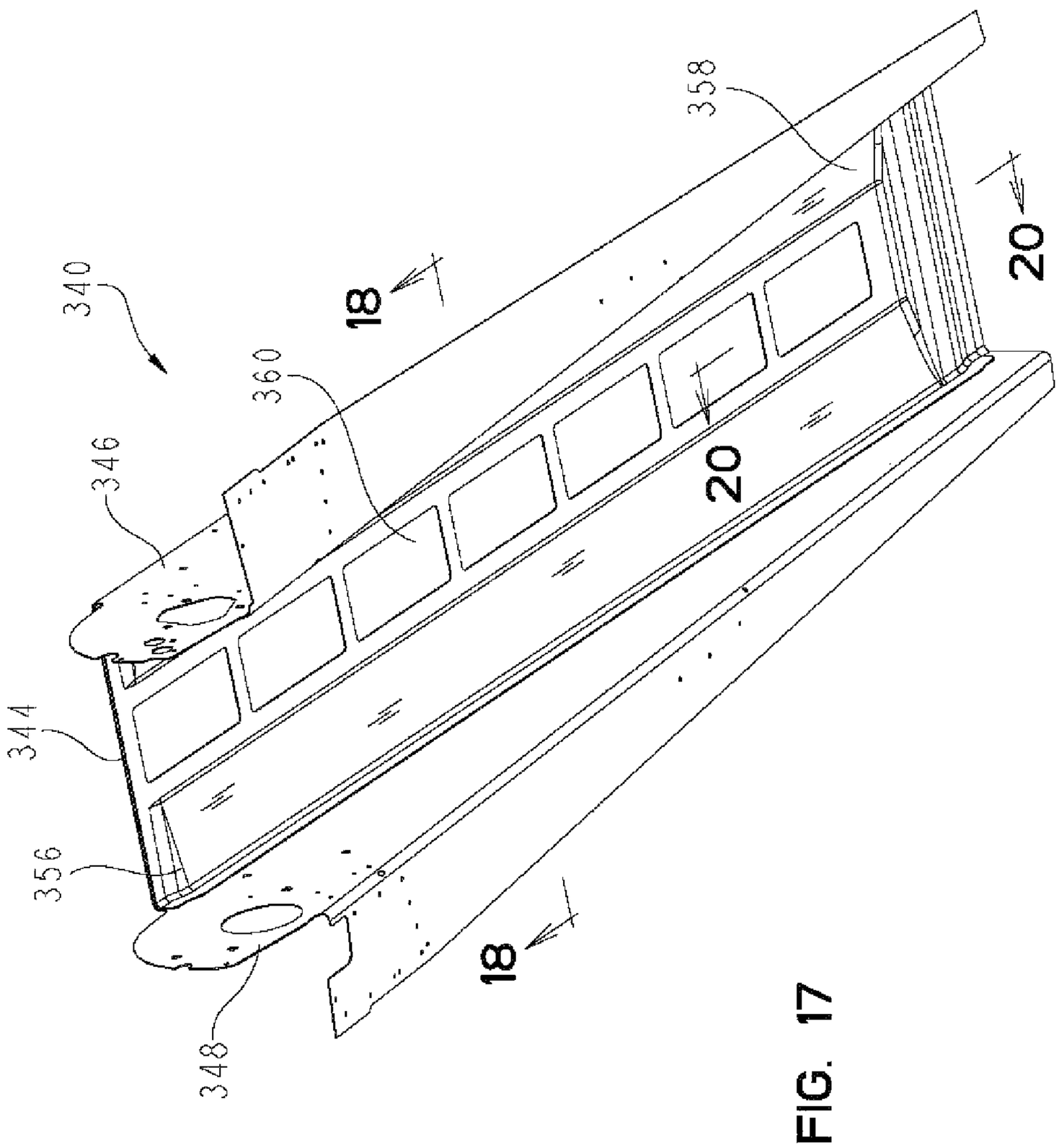


FIG. 17

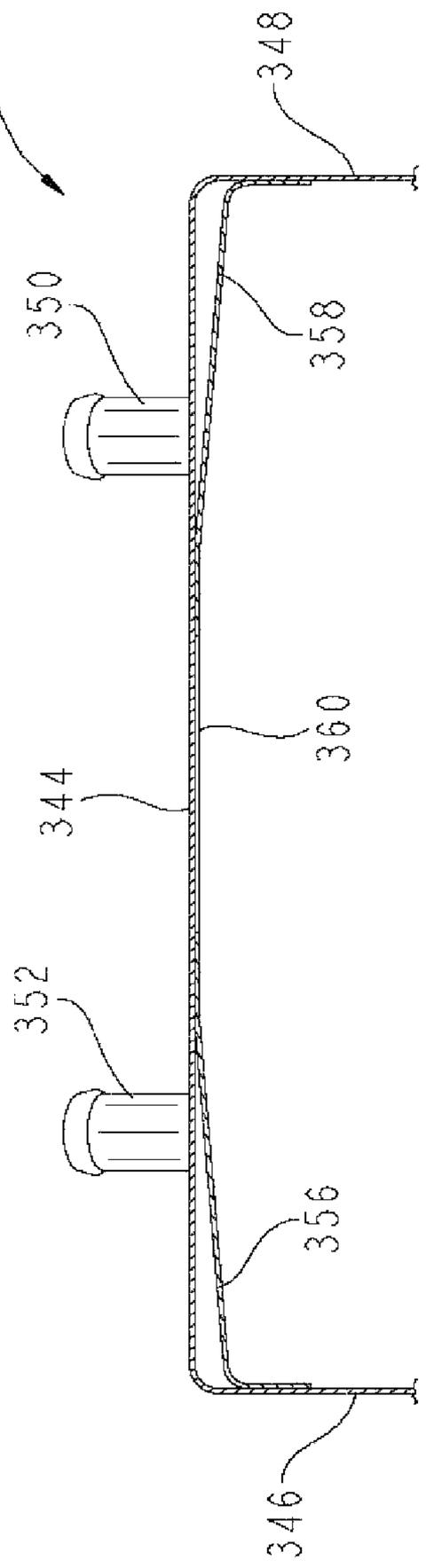

340
348
350
358
360
344
352
356
346

FIG. 18

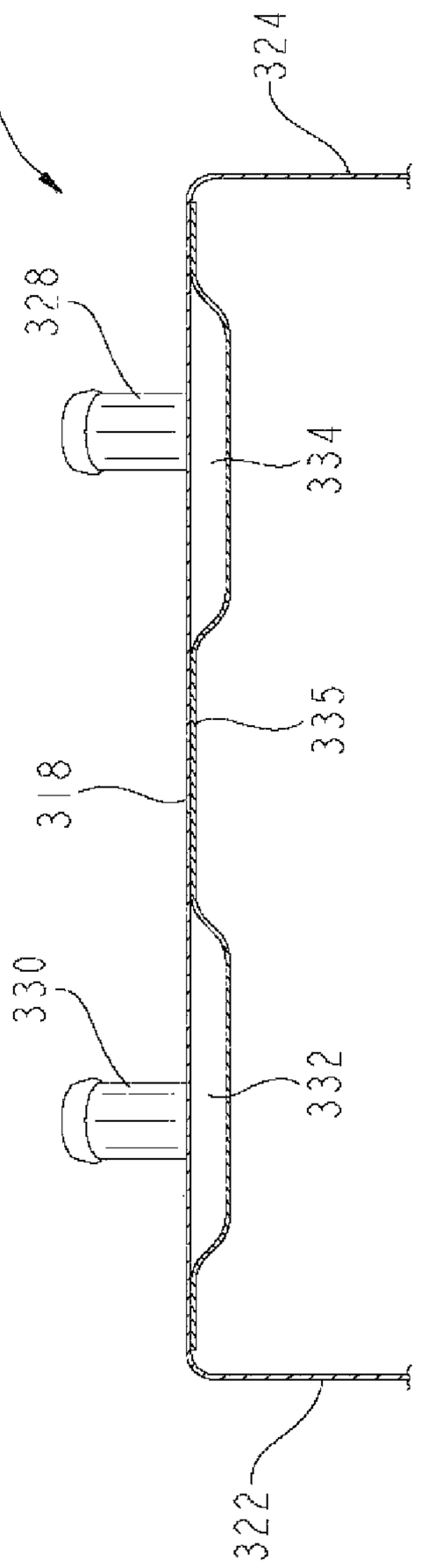

316
324
328
334
335
318
330
332
322

FIG. 19

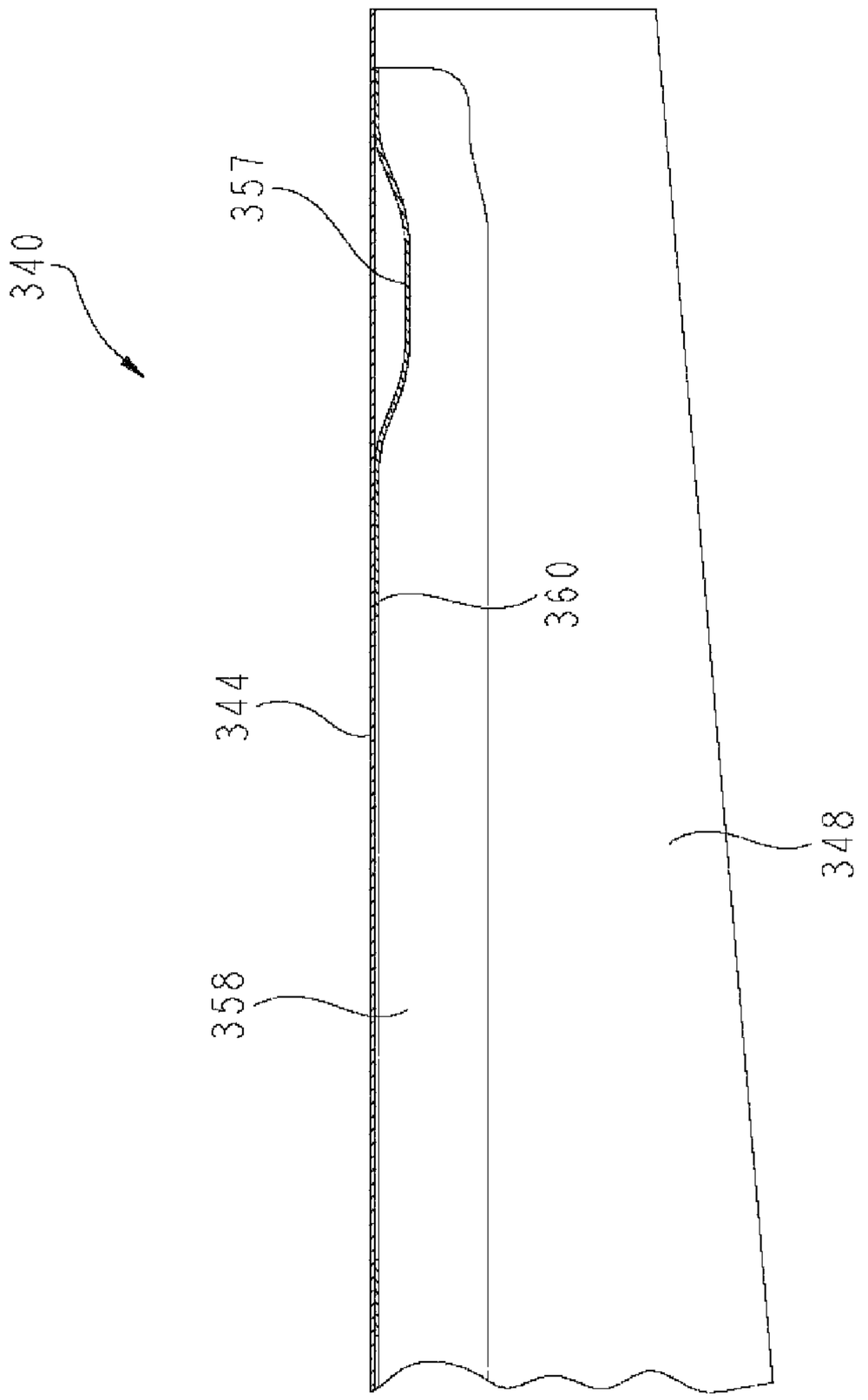


FIG. 20

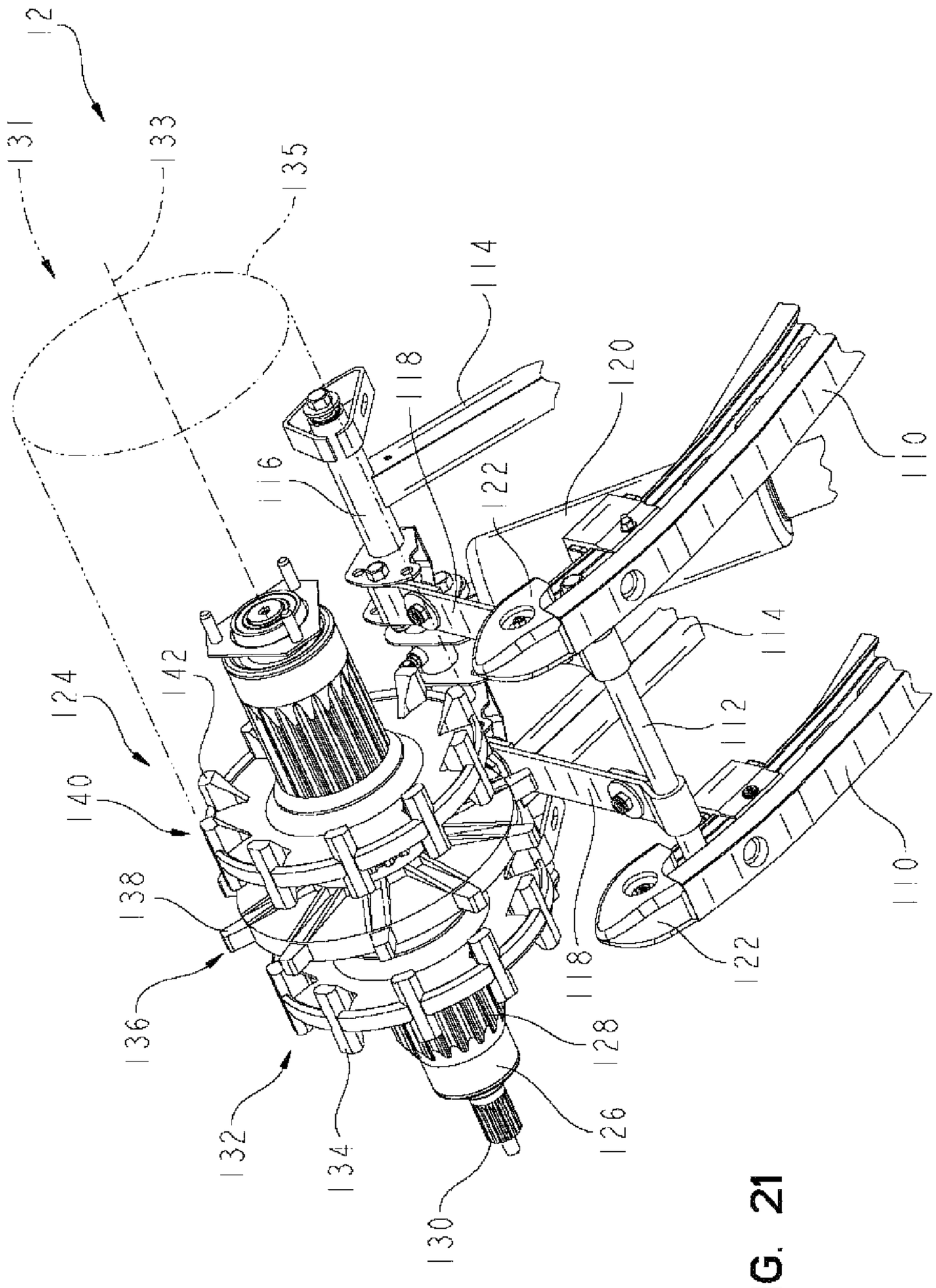

12
131
133
135
114
118
120
116
122
110
124
142
140
112
138
136
118
122
110
128
132
134
126
130

FIG. 21

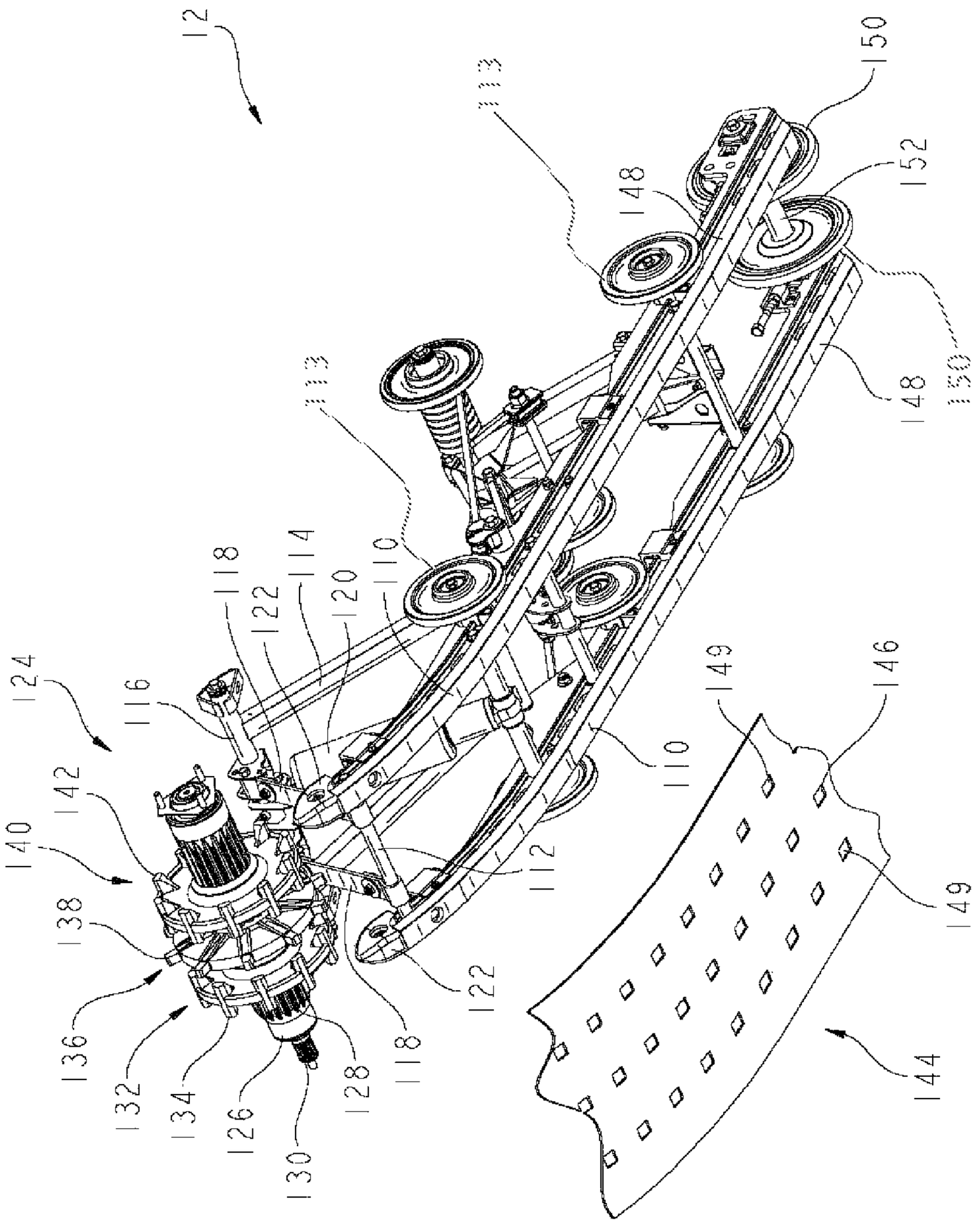

12
113
150
148
152
148
150
113
110
120
122
114
118
116
124
140
142
138
136
132
134
126
130
128
118
122
112
110
149
146
149
144

FIG. 22

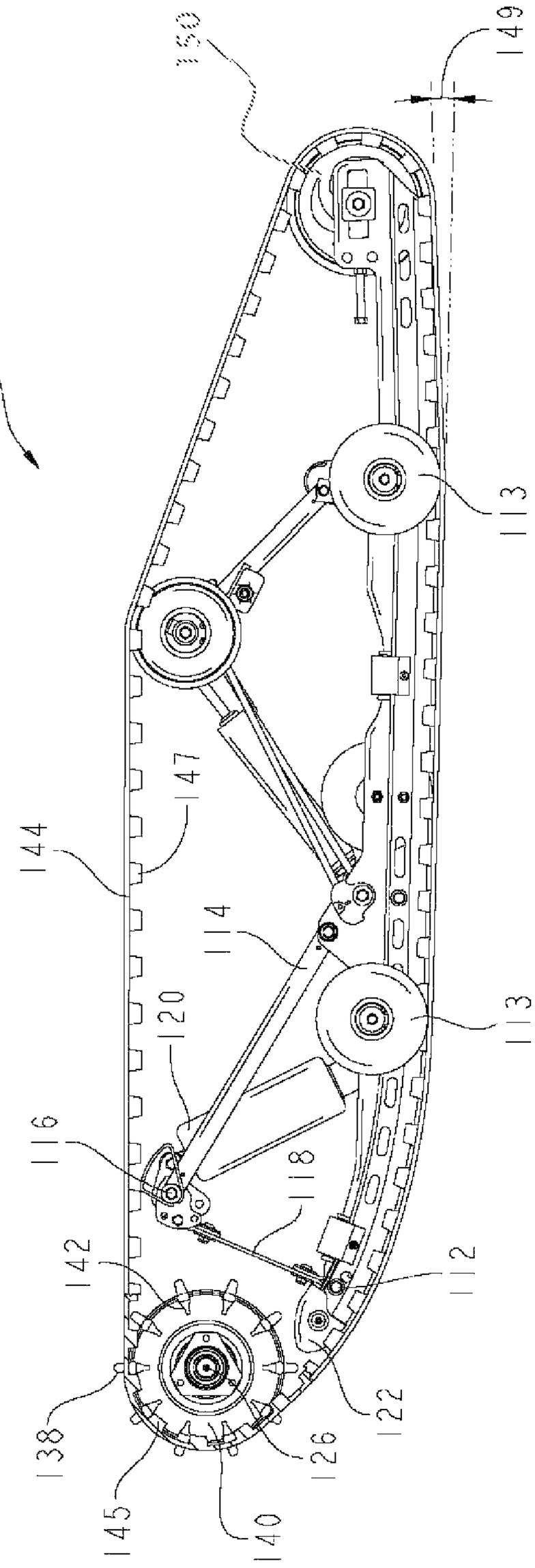

150
149
112
113
147
144
114
113
120
116
118
142
112
138
122
126
145
140

FIG. 23

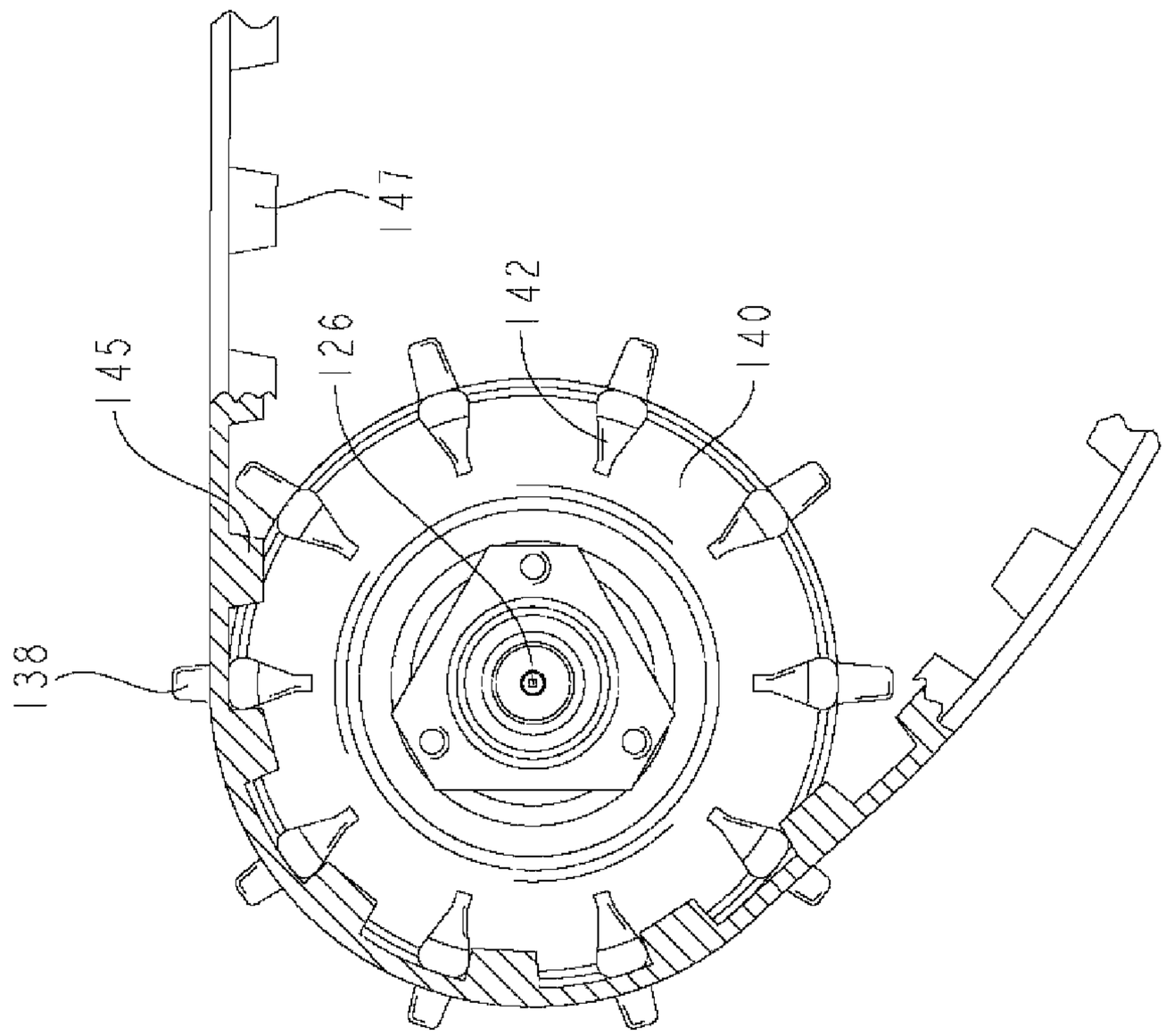


FIG. 24

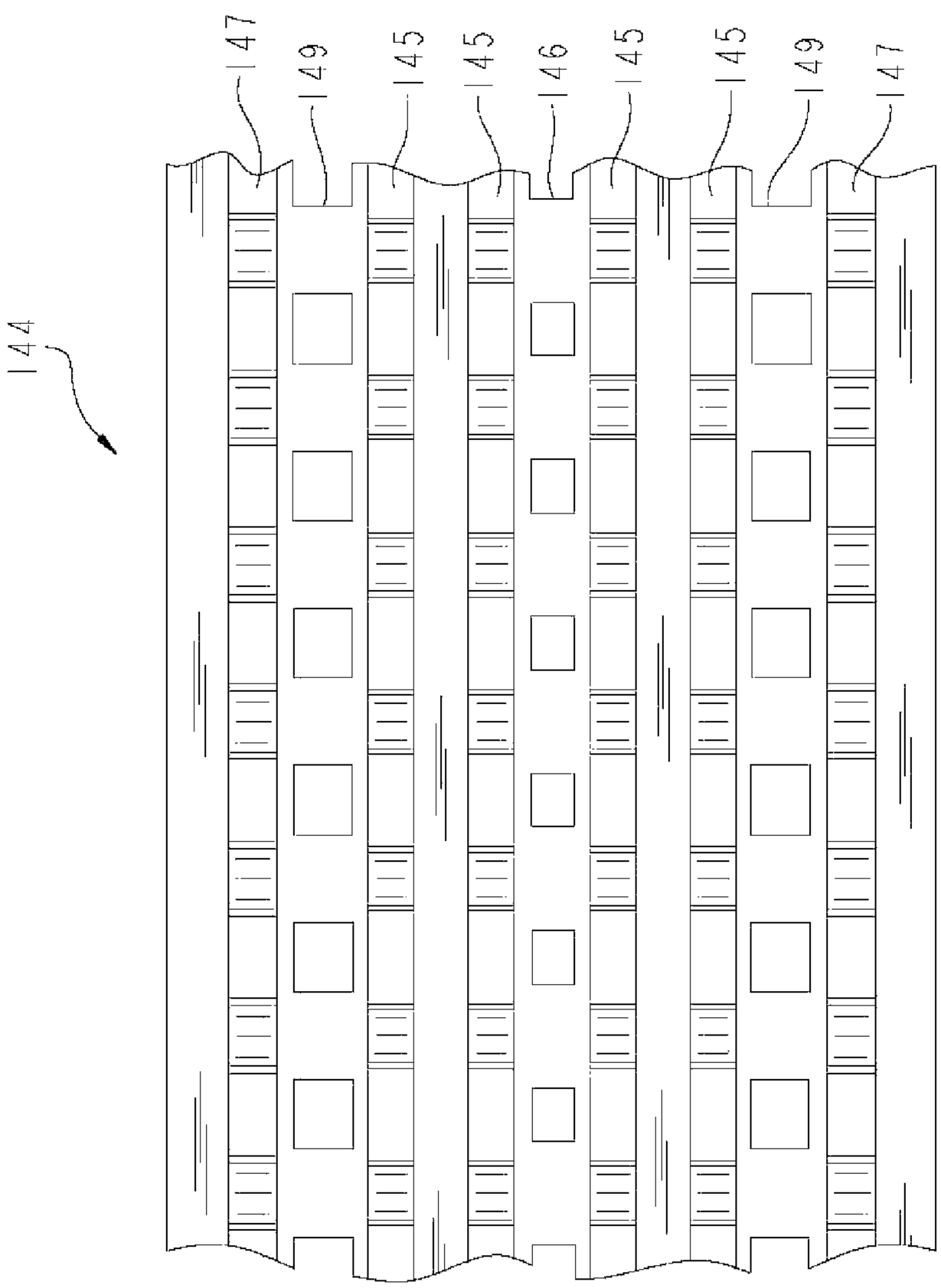


FIG. 25

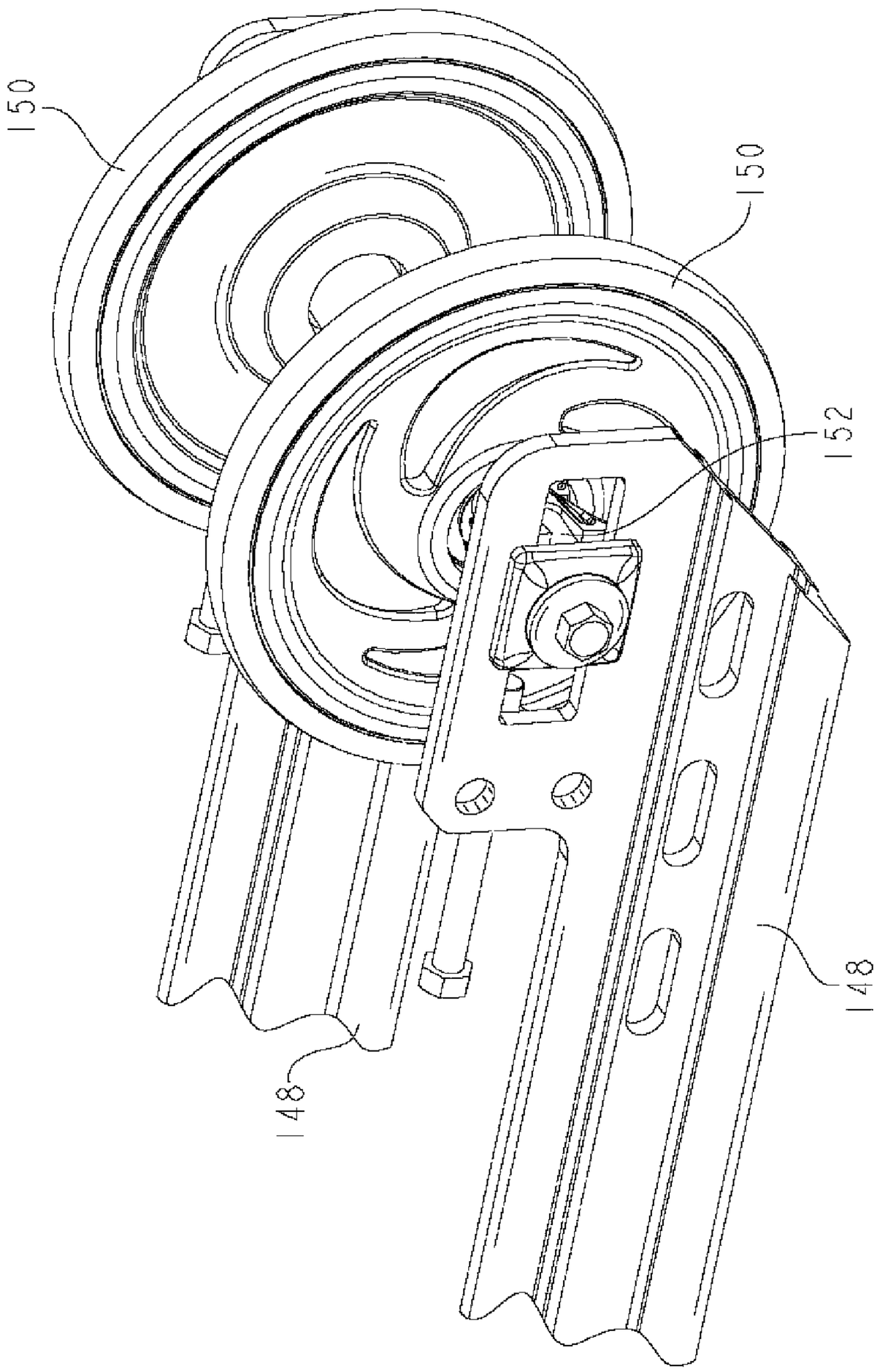


FIG. 26

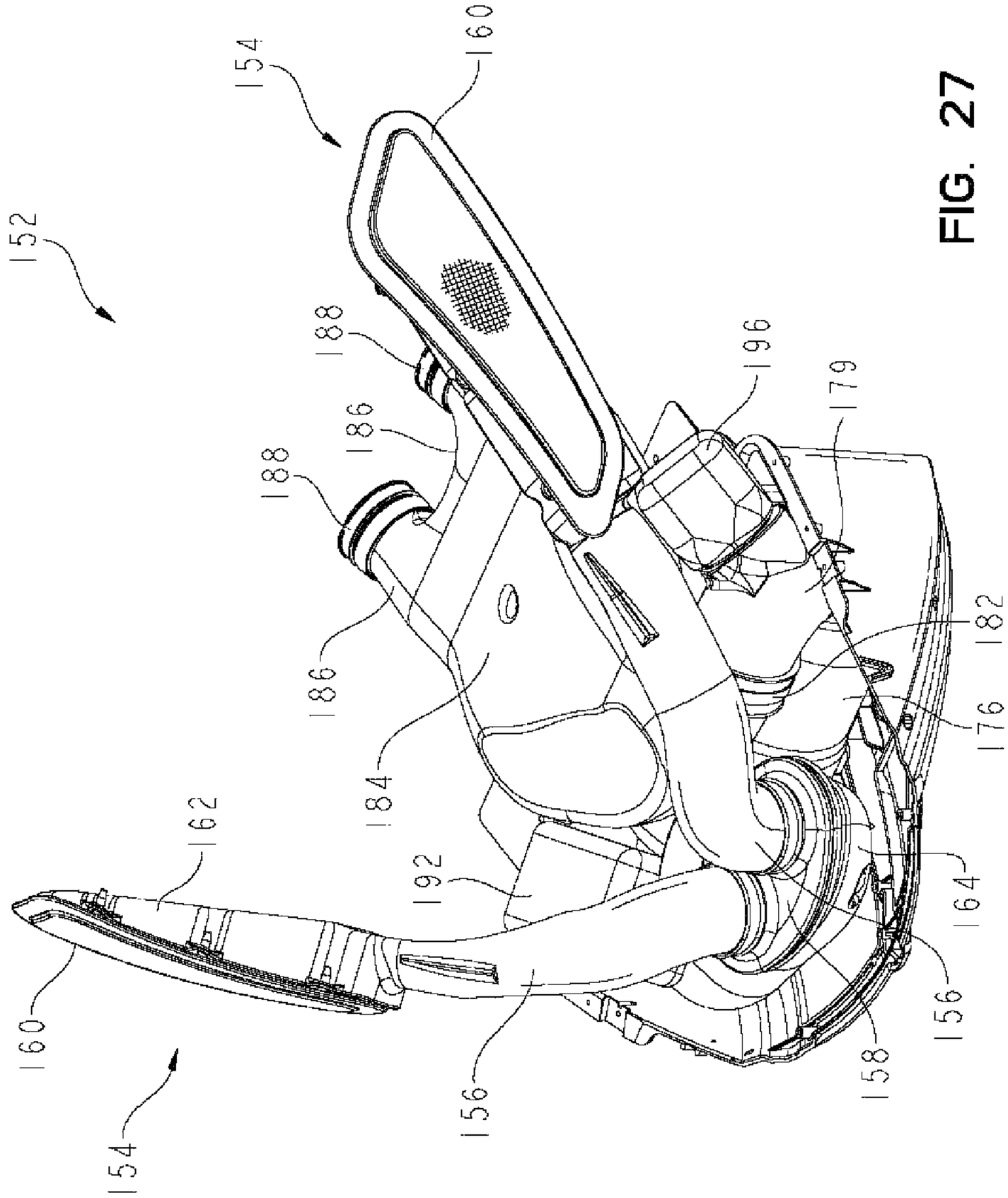


FIG. 27

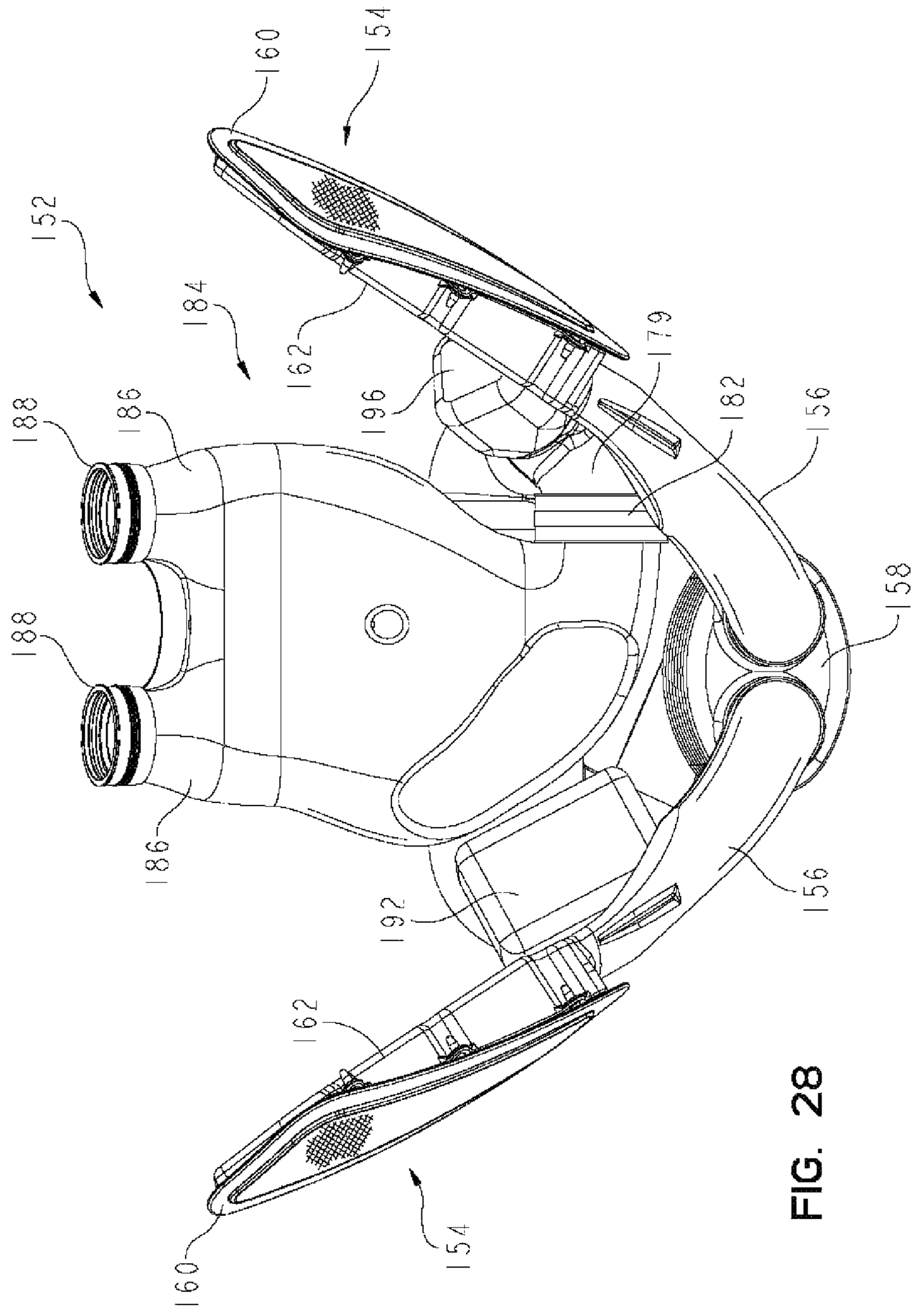

160
154
152
184
162
196
179
182
156
188
186
188
158
186
192
162
154
160

FIG. 28

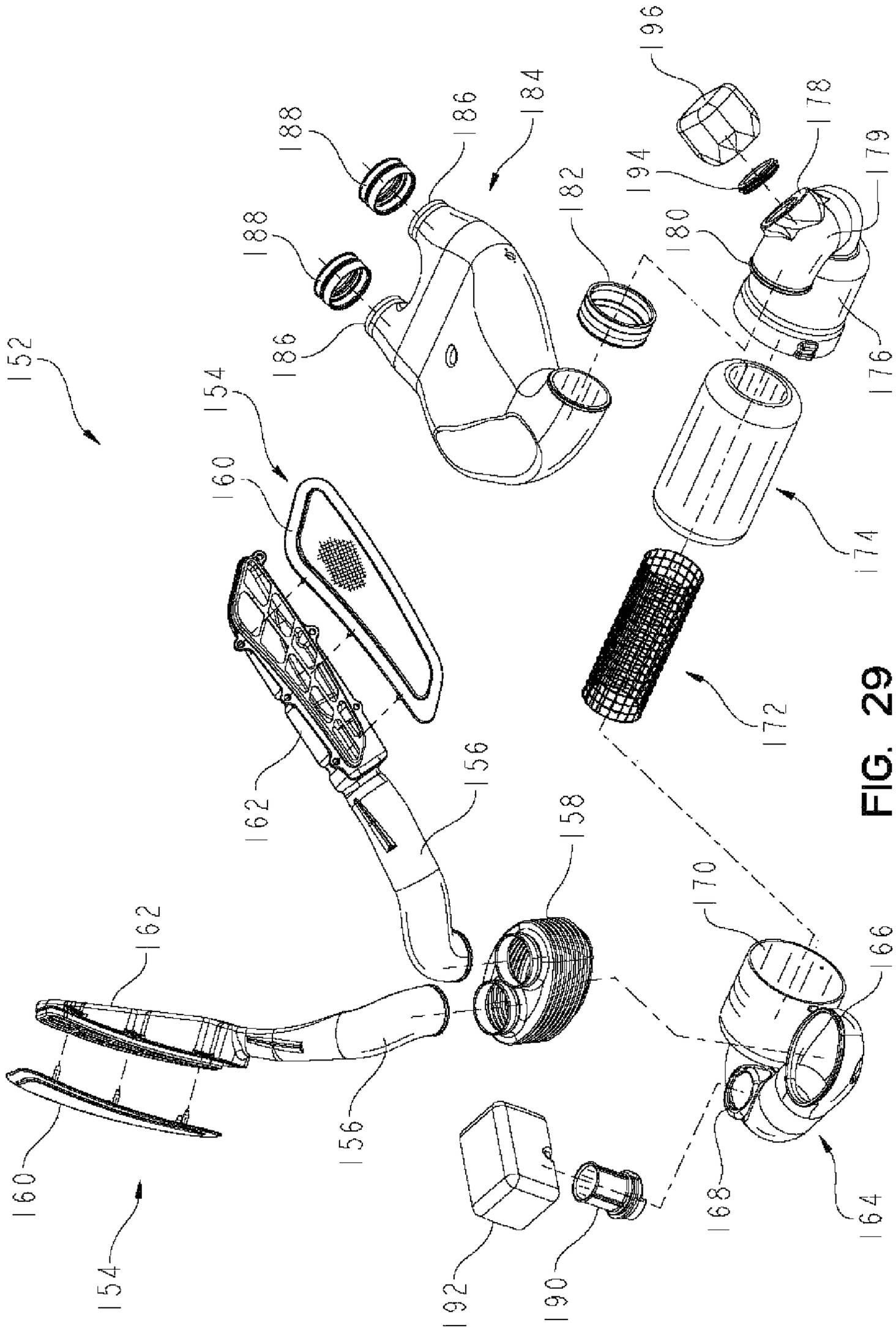

152
154
160
162
156
158
170
172
174
176
178
179
180
182
184
186
188
188
186
194
196
166
168
164
192
190

FIG. 29

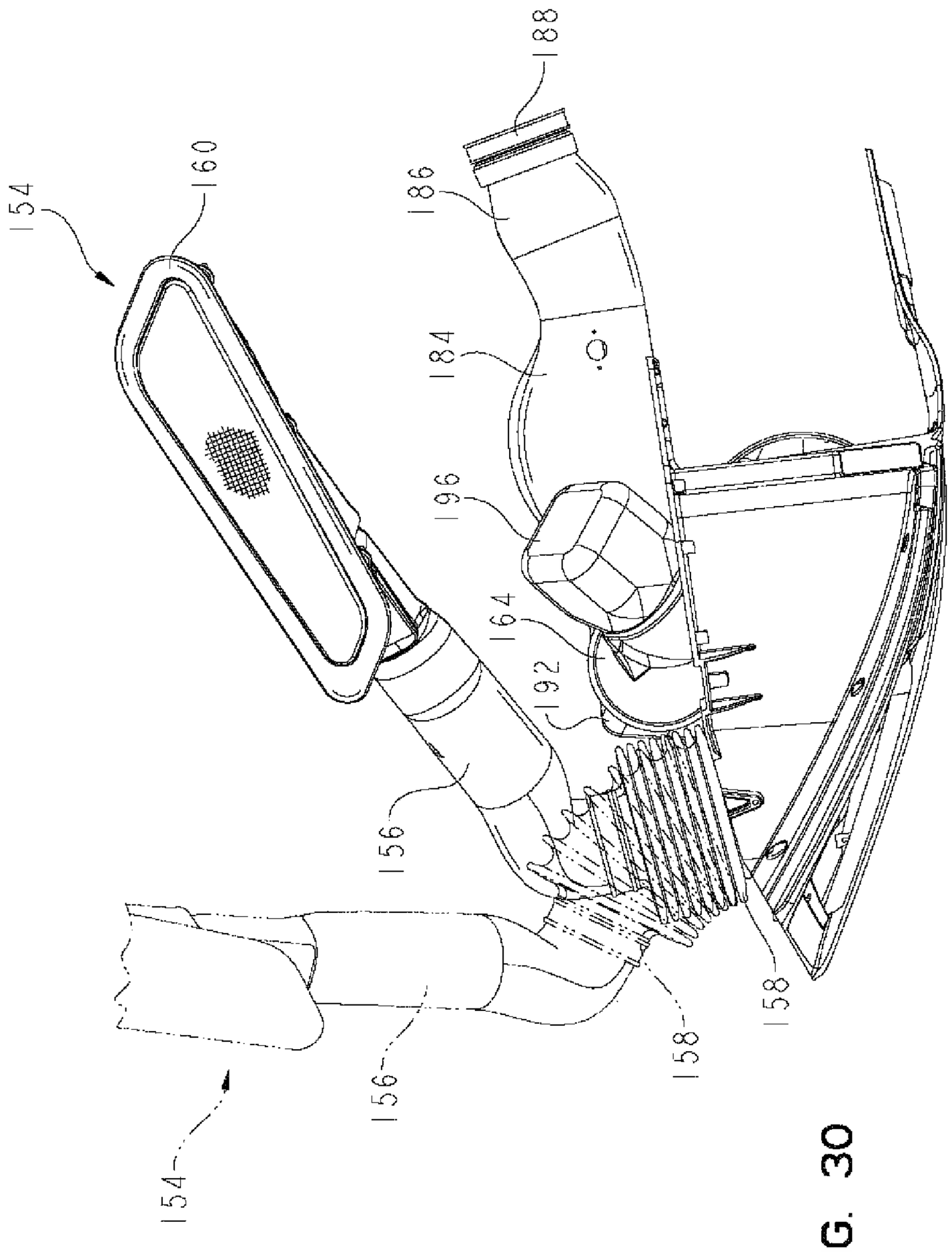


FIG. 30

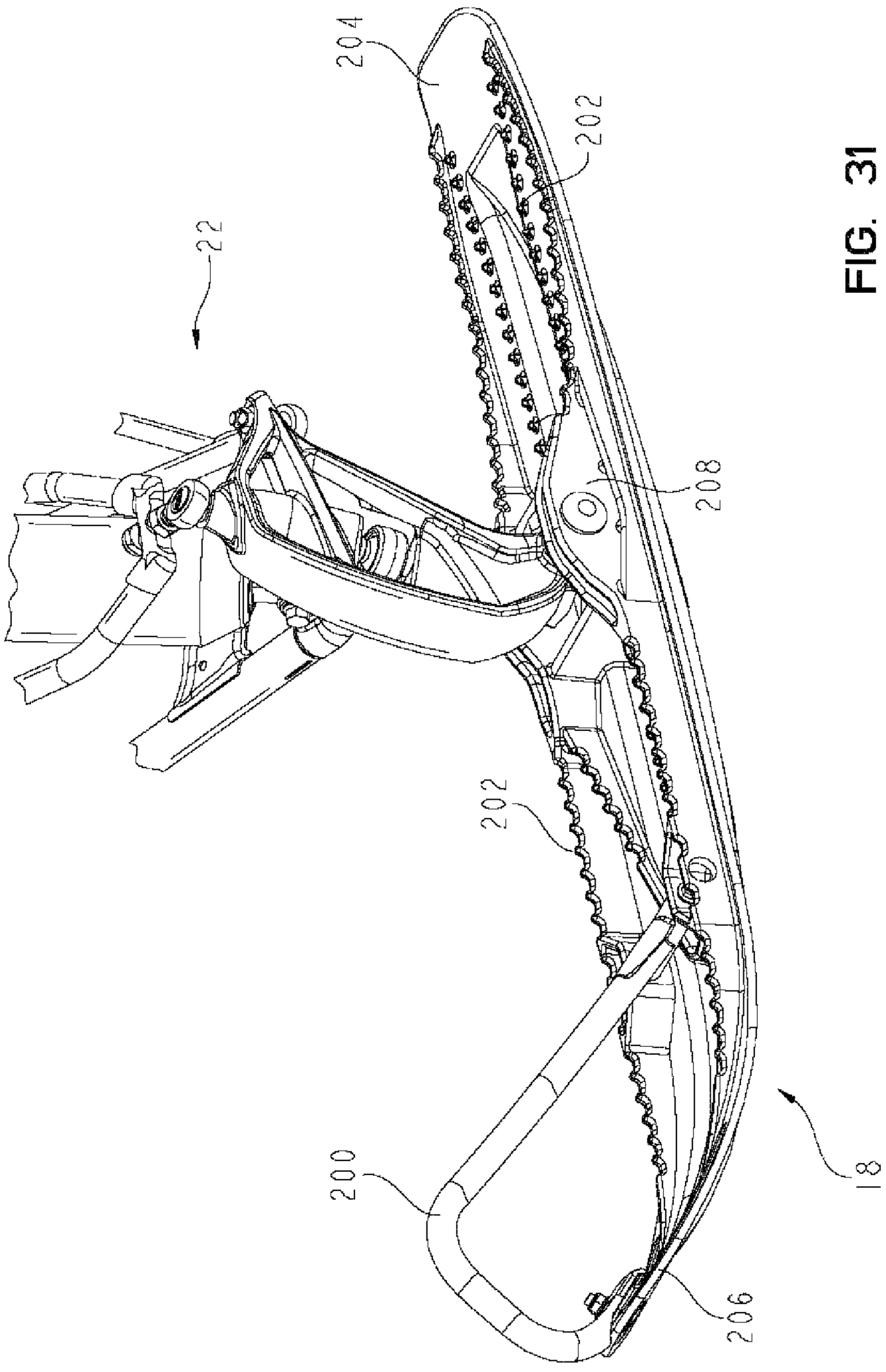


FIG. 31

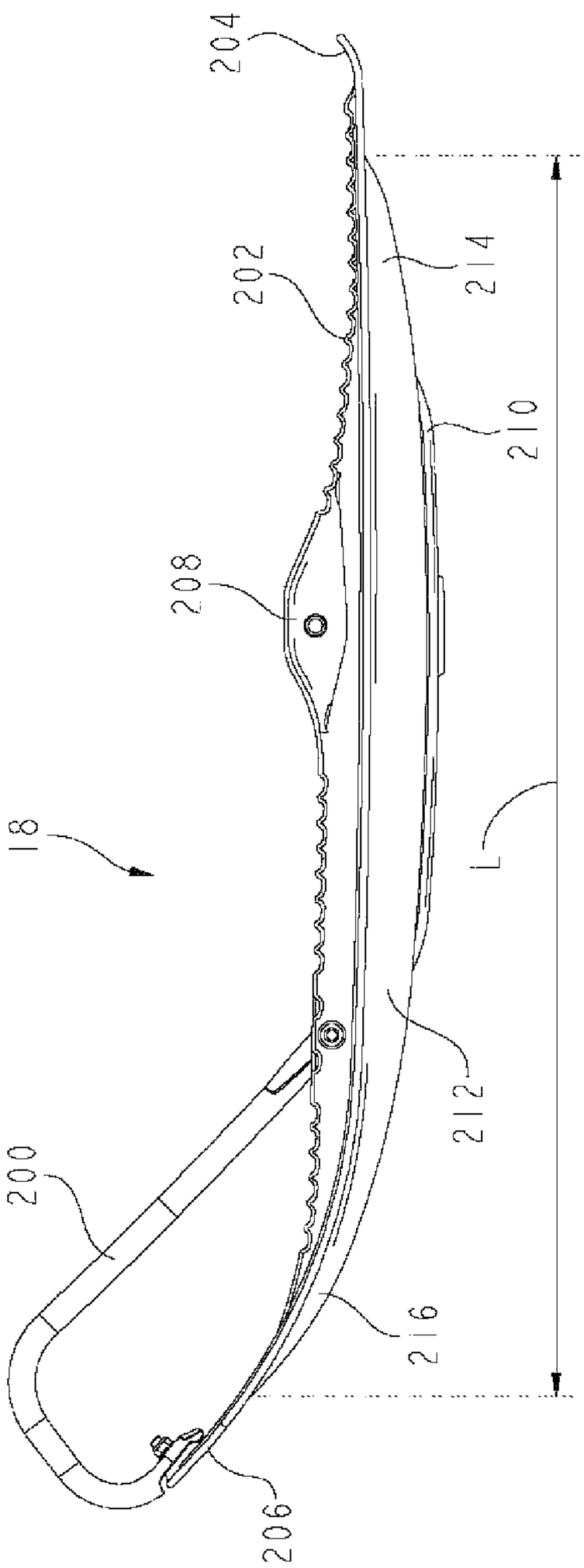


FIG. 32

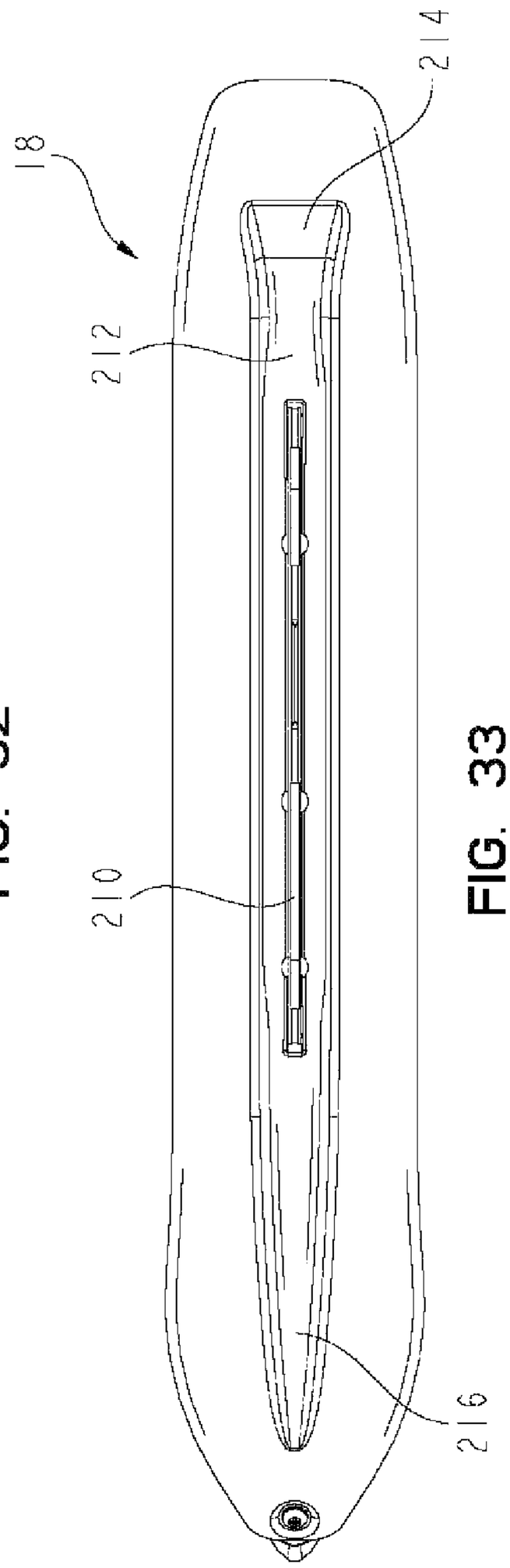


FIG. 33

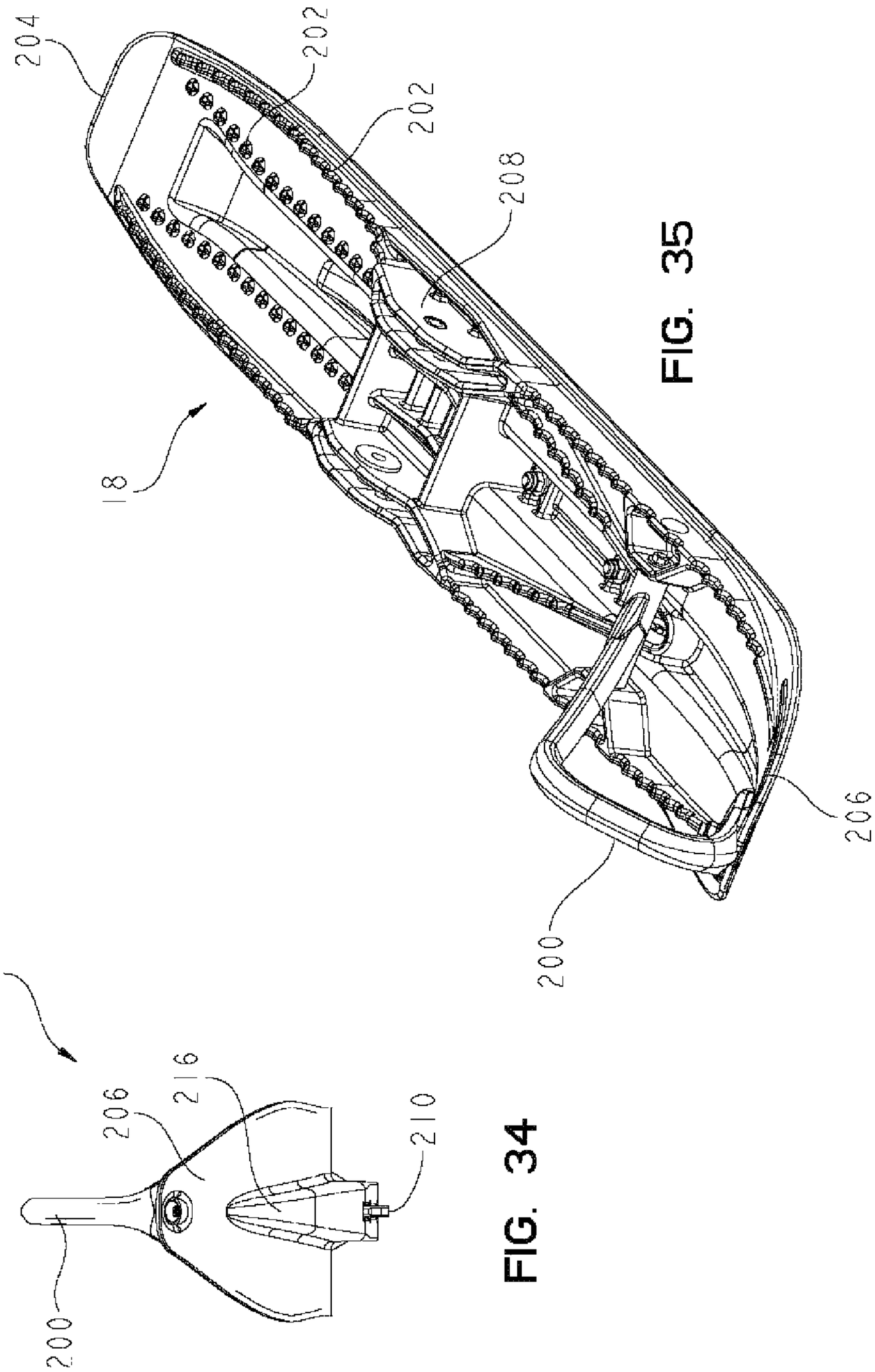


FIG. 35

FIG. 34

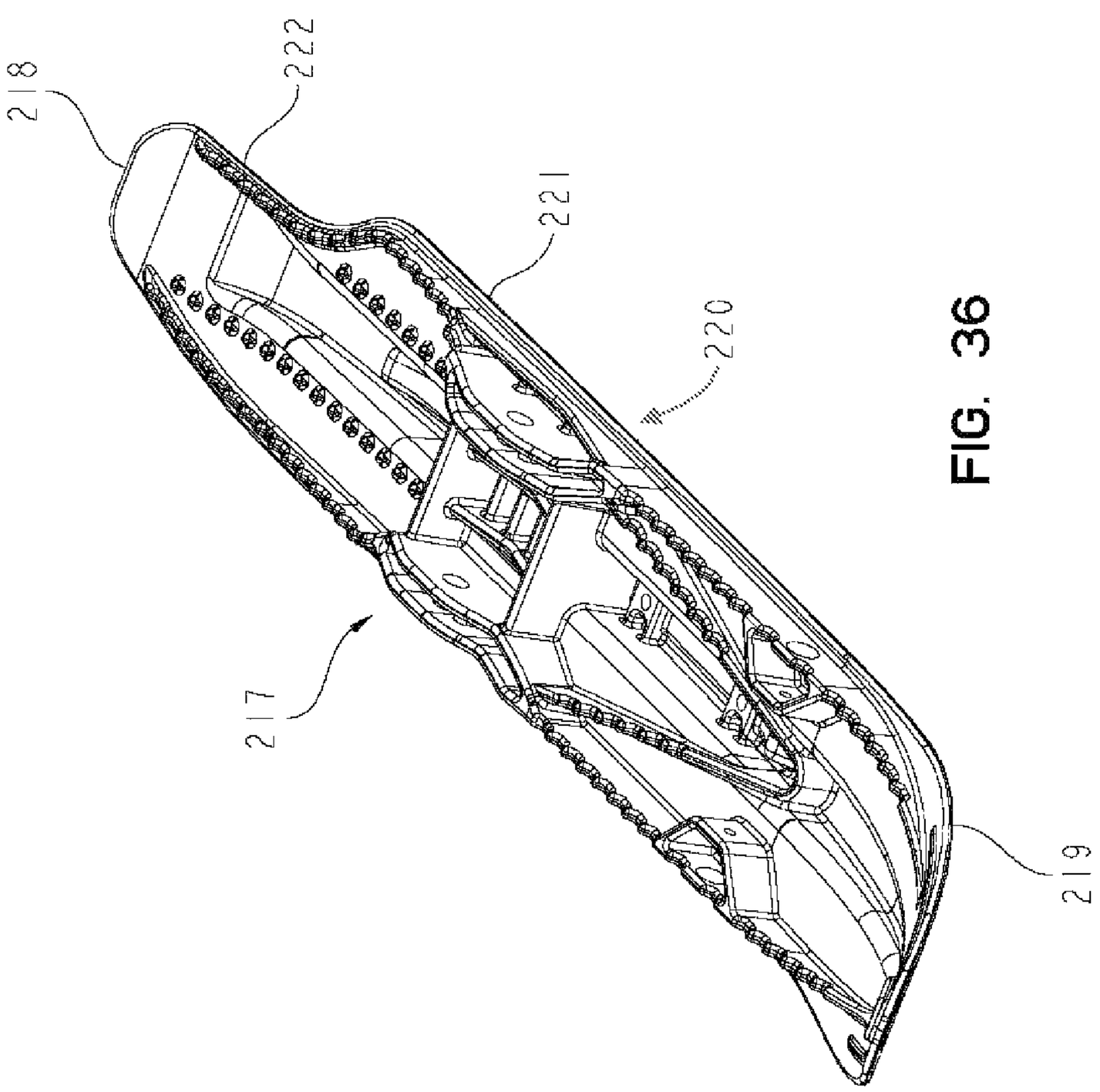


FIG. 36

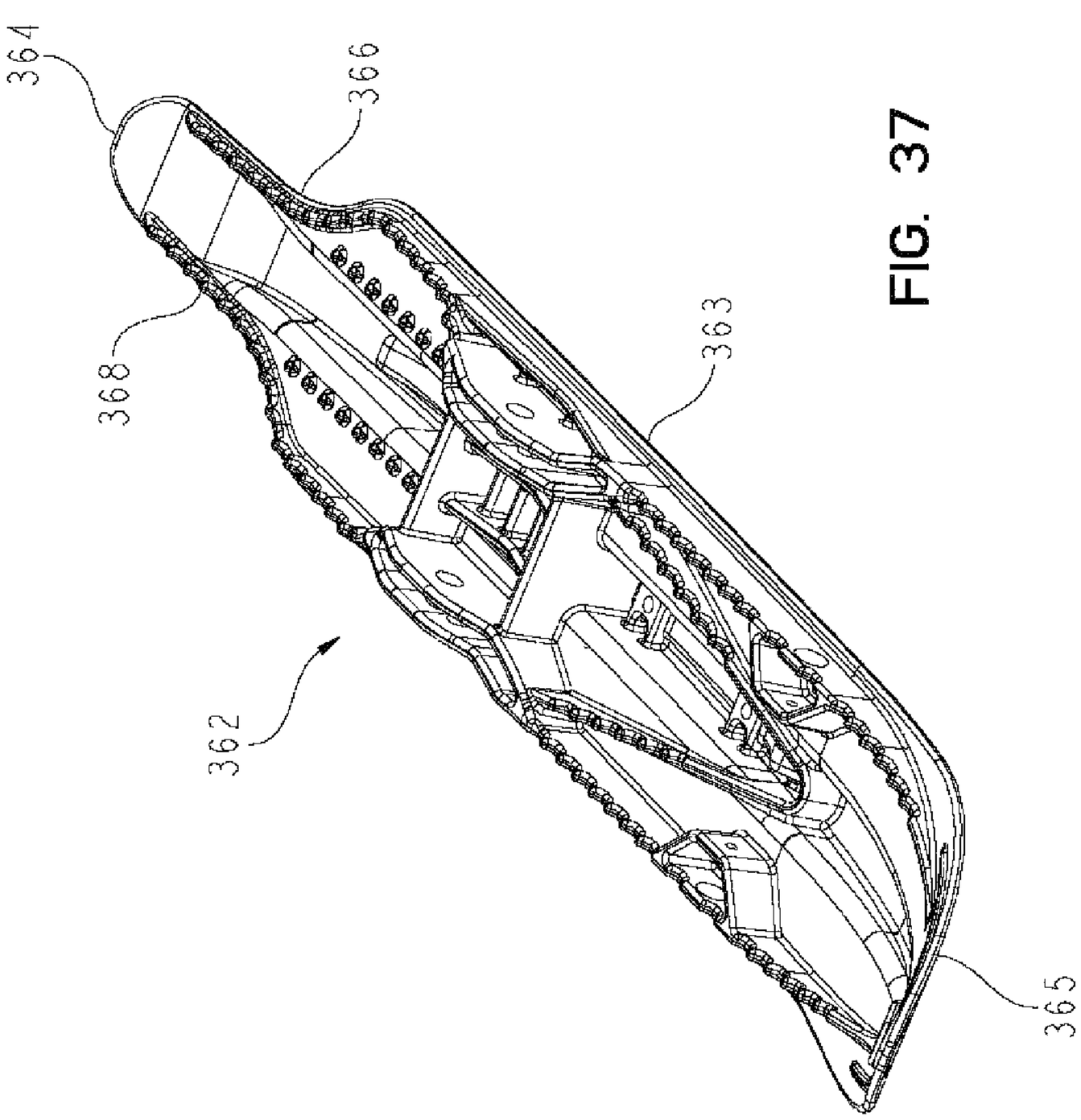


FIG. 37

SNOWMOBILE

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/773,326, filed on Feb. 21, 2013, which is a continuation of U.S. application Ser. No. 12/782,363, filed on May 18, 2010, now U.S. Pat. No. 8,381,857, which is a continuation-in-part of U.S. application Ser. No. 11/501,456, filed on Aug. 9, 2006, now abandoned, the disclosures of which are expressly incorporated by reference herein.

BACKGROUND AND SUMMARY

The present invention generally relates to snowmobiles. More particularly, the present invention relates to the components of a snowmobile such as the frame, skis, motor, and endless belt assembly.

Generally, there are a variety of configurations of snowmobiles available for applications such as deep snow, high performance, luxury touring, trail riding, etc. Most snowmobiles include a frame, a motor, a pair of front skis, and an endless belt assembly. Typically, features such as engine displacement and track length vary depending upon the specific application for which the snowmobile is targeted. For example, snowmobiles designed primarily for deep snow application may include an endless belt assembly having a longer track length, i.e. 166 inches, than a snowmobile designed primarily for trail riding, i.e. 135 inches. A snowmobile designed for deep snow may also include a relatively large displacement engine, i.e. 900 cc^3, to provide suitable power when operating in a mountain environment at higher elevations with less oxygen. Other features of a deep snow snowmobile may be added to improve ride and handling characteristics such as side hilling.

One illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering spindle operably coupled to the frame, and a pair of front skis operably coupled to the steering spindle, each of the front skis including upper and lower surfaces, the lower surfaces including a runner, the upper surfaces including a plurality of projections adapted to provide traction to an operator.

Another illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering arms operably coupled to the frame, and a pair of front skis operably coupled to the steering arms, each of the front skis including front and rear ends and inner and outer edges, the outer edge of the rear end of each ski including a notch.

Yet another illustrative embodiment of the present disclosure includes a snowmobile comprising a frame, a motor supported by the frame, an endless belt assembly supported by the frame, a pair of steering arms operably coupled to the frame, and a pair of front skis operably coupled to the steering arms, each of the front skis including front and rear ends and inner and outer edges, the inner and outer edge of the rear end of each ski including a notch.

Another embodiment of the present disclosure includes a snowmobile comprising a frame assembly including a steering hoop structure and a tunnel, the tunnel including a center plate and first and second side panels, the steering hoop structure coupled to the first and second side panels and extending above the tunnel, the first and second side panels each including a running board supported by the steering hoop structure, the steering hoop structure including a toe clip positioned adjacent to each of the running boards, a steering assembly supported by the steering hoop structure, a motor supported by the frame, and an endless belt assembly supported by the frame.

According to another illustrated embodiment of the present disclosure, a ski for a snowmobile includes a body portion having an upper surface and a lower surface, a keel formed on the lower surface, at least one longitudinally extending rib extending upwardly from the upper surface, and a plurality of projections arranged side by side and extending upwardly from a top edge of the at least one longitudinally extending rib. The plurality of projections are configured to provide traction to an operator.

According to yet another illustrated embodiment of the present disclosure, a ski for a snowmobile includes a body portion having an upper surface and a lower surface having a planar bottom portion. The body portion has a front end and a rear end establishing a length dimension of the ski and an inner edge and an outer edge establishing a width dimension of the ski. At least one of the inner edge and the outer edge of the rear end of the body portion includes a notched portion having a notch length dimension of at least one sixth of the length dimension of the ski and a notch width dimension of at least one fifth of the width dimension of the ski.

The above mentioned and other features of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of an illustrative embodiment snowmobile;

FIG. **2** is a perspective view of one embodiment of an integral frame and tunnel system of the snowmobile shown in FIG. **1**;

FIG. **3** is an exploded view of the left side of the integral frame and tunnel assembly shown in FIG. **2**;

FIG. **4** is an exploded view of the right side of the integral frame and tunnel assembly shown in FIGS. **2** and **3**;

FIG. **5** is a perspective view of the front end of the integral frame and tunnel assembly shown in FIGS. **2-4**;

FIG. **6** is a partial view of one embodiment of a running board of the snowmobile shown in FIG. **1**;

FIG. **7** is a perspective view of one embodiment of a tunnel assembly of the snowmobile shown in FIG. **1**;

FIG. **8** is an exploded view of the tunnel assembly shown in FIG. **7**;

FIG. **9** is a bottom view of the tunnel assembly shown in FIGS. **7** and **8**;

FIG. **10** is cross-sectional view of the rear end of the tunnel assembly shown in FIGS. **7-9**;

FIG. **11** is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. **7-10**;

FIG. **12** is a cross-sectional view taken across a section of one component of the heat exchanger shown in FIGS. **1-11**;

FIG. **13** is a cross-sectional view of an alternative embodiment heat exchanger similar to the heat exchanger shown in FIG. **12**;

FIG. **14** is an exploded view of another embodiment of a tunnel assembly that may be used in a snowmobile such as the one shown in FIG. **1**;

FIG. **15** is a perspective view of the bottom side of the tunnel assembly shown in FIG. **14**;

FIG. **16** is an exploded view of another embodiment of a tunnel assembly that may be used in a snowmobile such as the one shown in FIG. **1**;

FIG. **17** is a perspective view of the bottom side of the tunnel assembly shown in FIG. **16**;

FIG. **18** is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. **16** and **17**;

FIG. **19** is a cross-sectional view taken across a middle section of the tunnel assembly shown in FIGS. **14** and **15**;

FIG. **20** is a cross-sectional view taken longitudinally across the rear portion of the tunnel assembly shown in FIGS. **16-18**;

FIG. **21** is a partial perspective view of one embodiment of a drive system of the snowmobile shown in FIG. **1**;

FIG. **22** is a partial perspective view of one embodiment of an endless belt assembly of the snowmobile shown in FIG. **1**;

FIG. **23** is a partial profile view of the endless belt assembly shown in FIGS. **21** and **22**;

FIG. **24** is a partial profile view of the drive system of the endless belt assembly shown in FIGS. **21-23**;

FIG. **25** is a partial top view of the belt of the endless belt drive shown in FIGS. **21-24**;

FIG. **26** is a partial perspective view of the rear end of the endless belt assembly shown in the FIGS. **22** and **23**;

FIG. **27** is a perspective view of one embodiment of an air intake system of the snowmobile shown in FIG. **1**;

FIG. **28** is a partial top view of the air intake system shown in FIG. **27**;

FIG. **29** is a partial exploded view of the air intake system shown in FIGS. **27** and **28**;

FIG. **30** is a profile view of the air intake system shown in the FIGS. **27-29** with the movement of the expandable section shown in phantom;

FIG. **31** is a partial perspective view of one embodiment of a front ski on the left side of the snowmobile shown in FIG. **1**;

FIG. **32** is a profile view of the front ski shown in FIG. **31**;

FIG. **33** is a bottom side view of the front ski shown in FIGS. **31** and **32**;

FIG. **34** is a front view of the front ski shown in FIGS. **31-33**;

FIG. **35** is a perspective view of the top side of the front ski shown in FIGS. **31-34**;

FIG. **36** is a perspective view of another embodiment of a front ski that may be positioned on either side of the snowmobile shown in FIG. **1**; and

FIG. **37** is a perspective view of another embodiment of a front ski that may be positioned on the either side of the snowmobile shown in FIG. **1**.

Corresponding reference characters indicate corresponding parts throughout the several views. Although the drawings represent embodiments of the present invention, the drawings are not necessarily to scale and certain features may be exaggerated in order to better illustrate and explain the present invention.

DETAILED DESCRIPTION OF THE DRAWINGS

The embodiments disclosed below are not intended to be exhaustive or to limit the invention to the precise forms disclosed in the following detailed description. Rather, the embodiments are chosen and described so that others skilled in the art may utilize their teachings. For example, while the following description refers primarily to a snowmobile, it

should be understood that the principles of the invention apply equally to other snow vehicles. While the present invention primarily involves a snowmobile, it should be understood, however, that the invention may have application to other types of vehicles, such as motorcycles, ATVs, utility vehicles, scooters, and mopeds.

Referring to FIG. **1**, one illustrative embodiment of a snowmobile **10** is shown. Snowmobile **10** includes endless belt assembly **12**, seat assembly **14**, hood **16**, steering assembly **17**, front skis **18**, frame **20**, and steering arms **22**. Steering assembly **17** is operably coupled to steering arms **22** and allows a rider to steer snowmobile **10**. A motor, not shown, is covered by hood **16** and provides power to endless belt assembly **12**.

Referring now to FIG. **2**, tunnel assembly **22** and integrated steering hoop assembly **24** of frame **20** are shown. Steering hoop assembly **24** supports steering assembly **17** of snowmobile **10** and provides structural support to snowmobile **10**. Steering hoop assembly **24** also provides attachment points for body panels such as the hood. Additionally, steering hoop assembly **24** provides lateral support in the event of snowmobile roll-over and prevents or reduces body panel collapse. Steering hoop assembly **24** includes inner hoop **26** and outer hoop extensions **28** and **30**. Inner hoop **26** extends around the motor of snowmobile **10**. Referring now to the components on the left side of frame **20**, best shown in FIG. **3**, an upper end of outer hoop **28** couples to inner hoop **26**. A lower end of outer hoop **28** couples to longitudinally extending tube **42**. Additionally, extension **40** extends rearwardly from the lower end of outer hoop **28**. Extension **40** is coupled to one end of tube **44**. The opposing end of tube **44** is coupled to inner hoop **26**. Portions of outer hoop **28**, extension **40**, and tube **44** define a foot grip assembly configured to support a rider's boot when the rider is operating snowmobile **10**. As shown in FIG. **3**, a first flange at the forward end of longitudinally extending tube **42** is removably coupled to a portion of the foot grip assembly, illustratively outer hoop **28**, with removable fasteners.

Console side **36** is coupled to inner hoop **26** and outer hoop **28** with removable fasteners, as shown in FIG. **3**. Console side **36** defines a portion of the foot grip assembly and includes louvered portion **38** and lower portion **35**. Both louvered portion **38** and lower portion **35** allow heated air from the engine compartment under hood **16** to exit the engine compartment and provide heat to a rider's leg and boot. Lower portion **35** is coupled to running board **46** with removable fasteners, as shown in FIG. **3**. In this embodiment, running board **46** is integral with side panel **52** of tunnel assembly **22**, however running board **46** may be a separate component. Outer edge **76** of running board **46** is supported by longitudinally extending tube **42** substantially along the length of running board **46** and is illustratively removably coupled thereto with removable fasteners as shown in FIG. **3**. Longitudinally extending tube **42** includes offset portion **48** and bracket **50** which is coupled to side panel **52** of tunnel **22**. Illustratively, bracket **50** is removably coupled to side panel **52** with removable fasteners, as shown in FIG. **3**. It may be appreciated that the right side of frame **20** is configured identically to the left side thereof, as disclosed further herein and shown in FIG. **4**.

Referring now to FIG. **4**, the components of the right side of frame **20** is shown. The components on the right side of frame **20** are in a similar arrangement and compliment the components on the left side of frame **20**. Outer hoop **30** is coupled on an upper end to inner hoop **26**. A lower end of outer hoop **30** is coupled to longitudinally extending tube **62**. The lower end of outer tube **30** also includes extension **60**

which is coupled to one end of tube **54**. The opposing end of tube **54** is coupled to inner hoop **26**. Console side **32** is coupled to outer hoop **30** and includes louvered portion **34** and lower portion **37**. Louvered portion **34** is similar to louvered portion **38** of console side **36**. Lower portion **37** of console side **32** couples to running board **64** which, in this embodiment, is integral with side panel **58** of tunnel **22**.

Running board **64** includes outer edge **63** which is supported by longitudinally extending tube **62**. Longitudinally extending tube **62** includes offset portion **68** and bracket **70** which couples to side panel **58** of tunnel **22**. Offset portions **48** and **68** of longitudinally extending tubes **42** and **62** may be used as handle portions by snowmobile operator. Offset portions **48** and **68** extend upwardly and rearward to bracket **70** to provide the rider with a handle that is generally perpendicular to running board **64**. Additionally, tube **56** which is coupled on a first end to a rear section of side panel **52** and on a second end to a rear portion of side panel **58** may be used as a handle portion by a snowmobile operator.

Referring now to FIGS. **1** and **5**, a rider positioned on seat assembly **14** has a boot positioned on each running board **46** and **63**. The rider's boots are positioned substantially below tubes **44** and **54** of integral steering hoop assembly **24**. In this orientation, a rider may contact or hook the toe of each boot under tubes **44** and **54** to maintain balance or control of snowmobile **10** during snowmobiling.

Referring now to FIG. **6**, a partial section of one embodiment of running board **46** is shown. In this embodiment, running board **46** includes a plurality of apertures **72** adapted to allow snow and ice from a rider's boot to pass through and a plurality of extensions **74** to engage a rider's boot. In this embodiment, apertures **72** a substantially flat to allows snow and water collected on running board **46** to exit. Additionally, running board **46** includes a plurality of offset projections **78** on outer edge **76**. Offset projection **78** have an angular orientation relative to a longitudinal axis of running board **46**. The angular orientation of projections **78** or skewed relationship of projections **78** to the running board **46** provides traction to a rider's boot. In this embodiment of snowmobile **10**, running board **63** also includes the features of running board **46** described above. It should be noted that any suitable arrangement of drainage apertures and/or traction devices may be used on running boards **46** and **63** of snowmobile **10**.

Referring now to FIG. **7**, a profile view of tunnel **22** is shown. As shown in FIG. **1**, tunnel **22** extends over endless belt assembly **12** and prevents snow and ice from contacting the rider positioned on seating assembly **14**. Tunnel **22** includes side panel **52**, heat exchanger **82**, center panel **80**, heat exchanger **86**, and side panel **58**. Heat exchangers **82** and **86** are coupled to the center panel **80** to form the top surface of tunnel **22**. Side panel **52** is coupled to heat exchanger **82** to form the left side of tunnel **22** and side panel **58** is coupled to heat exchanger **86** to form the right side of heat exchanger **22**. Bracket **102** is coupled to the rear end of heat exchangers **82** and **86** and may support a flap of material such as rubber to prevent snow from being thrown on the back of the rider. Heat exchanger **82** includes input **84** and plurality of channels **94** formed therein. Similarly, heat exchanger **86** includes output **88** and plurality of channels **96** formed therein.

Coolant from the motor of snowmobile **10** flows into inlet **84** and travels through heat exchangers **82** and **86** before exiting through output **88**. In the illustrative embodiment, inlet **84** and output **88** are positioned on an end of tunnel **22**, however they may be positioned at any suitable position along the longitudinal length of tunnel **22**. Endless track assembly **12**, which is positioned below tunnel **22**, throws snow and ice upward to contact heat exchangers **82** and **86**. The snow and ice provide and cooling effect for the coolant as is passes through heat exchangers **82** and **86**. At the same time, heat from heat exchangers **82** and **86** prevent snow and ice build-up and packing under tunnel **22**. In this embodiment, heat exchangers **82** and **84** are formed from extruded aluminum. However, any suitable material and method of construction may be used.

Referring now to FIGS. **8** through **10**, end caps **100** are coupled to each end of heat exchangers **82** and **86** to seal channels **94** and **96** respectively, the rear end of heat exchangers **82** and **86** is coupled to conducting duct **98**. Conducting duct **98** allows fluid to pass from heat exchanger **82** to heat exchanger **86**. In operation, heated coolant from the motor enters heat exchanger **82** through inlet **84** and flows through channels **94** to conducting duct **98**. The coolant is then directed to the rear end of heat exchanger **86** and passes through channels **96** exiting heat exchanger **86** at outlet **88** and returning to the motor of snowmobile **10**.

Referring now to FIG. **11**, heat exchanger **82** includes a lower extension **83** and a flange **104** extending the longitudinal length of heat exchanger **82**. As shown, the top edge of side panel **52** is adapted to be positioned between lower extension **83** and flange **104**. Side panel **52** may be secured in this position by adhesive, rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. Similarly, side panel **86** includes lower extension **92** and flange **102** which extend the entire longitudinal length of heat exchanger **86**. Side panel **58** is adapted to be positioned between flange **102** and lower extension **92**. Side panel **58** may be coupled to heat exchanger **86** by adhesive rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. In a similar fashion, center panel **80** is coupled between heat exchangers **82** and **86**. Heat exchanger **82** includes lateral extension **81** and lateral flange **77** extending the longitudinal length of heat exchanger **82**. One edge of center panel **80** is positioned between lateral extension **81** and lateral flange **77**. Heat exchanger **86** includes also includes lateral extension **85** and lateral flange **87**. The opposing edge of center panel **80** is secured between lateral extension **85** and flange **87**. Center panel **80** may be secured to heat exchangers **82** and **86** by adhesive, rivets, machine screws, bolt, any combination thereof, or any other suitable fastener. It should be noted that the width of center panel **80** may be varied to produce a tunnel having any suitable width. Additionally, in this embodiment, tunnel **22** is a modular design and may be constructed to any suitable length. In other embodiments, center panel **80** may be eliminated and heat exchangers **82** and **86** may be coupled directly together.

Referring now to FIG. **12**, heat exchangers **82** and **86** also include longitudinally extending slots or recesses **79** and **90**, respectively. Slots **79** and **90** provide a tunnel top attachment feature positioned along the longitudinal axis of the snowmobile. It should be noted that slots **79** and **90** may extend along the entire length of tunnel **22** or may extend only partially along the length of tunnel **22**. Additionally, slots **79** and **90** may be positioned anywhere on the outer periphery of tunnel **22**, such as the in or on side panels **52** and **58**. Slots **79** and **90** are adapted to receive a fastener that may be used to secure accessories, handles, tool kits, or any other suitable item to tunnel **22**. In this embodiment, slots **79** and **90** are integral to the tunnel assembly and prevent the need to any mounting holes or apertures in the tunnel assembly, which may weaken the tunnel assembly. In this embodiment, slots **79** and **90** are substantially inverted T-shapes, however, any suitably shaped slot may be used.

An alternative embodiment of slots **79**, **90** is shown in FIG. **13**. Heat exchanger **300** is similar to heat exchanger **82** with the exception that slot **312** is formed in recess **314** of channel **302** so that the top surface of slot **312** is flat or coplanar with the later extension **308**. Slots **79** and **312** are inverted T-shaped slots, however any suitable shaped slot may be used. Additionally, an upwardly extending protrusion such as a T-shaped protrusion may be used instead of or in combination with a slot to provide an attachment surface. In other embodiments, a plate including a longitudinally extending slot and/or protrusion may be affixed to the top of the tunnel to provide an attachment feature above the tunnel of a snowmobile. In yet another embodiment, slots or protrusions may be integral with or attached to side panels **52** and/or **58** to provide attachment features. Another method of providing attachment features is described in U.S. Pat. No. 7,055,454, which is expressly incorporated by reference herein.

Referring now to FIGS. **14** and **15**, an alternative embodiment of the tunnel assembly for in FIGS. **7-11** is shown. Tunnel assembly **316** includes tunnel **318** which is formed by a single sheet of metal and includes side panels **322** and **324** and center panel **320**. Center panel **318** includes inlet **330** and outlet **328** which are coupled to the liquid cooling system of the snowmobile, as discussed above. Tunnel assembly **316** also includes lower panel **326**. Lower panel **326** includes channels **332** and **334**, end channel **335**, and center section **336**. Lower panel **326** is coupled to the bottom side of center panel **318** to form a heat exchanger similar to the one described in FIGS. **7-11**. A cross-sectional view is shown in FIG. **19**. Coolant enters inlet **300** and flows down channel **332** to end channel **335**. The coolant then flows from end channel **335** to channel **334** and to outlet **328**. Center section **336** is also coupled to the lower side of center panel **318** to separate channels **332** and **334**. Channels **332** and **334** may include a plurality of surfaces adapted to improve the heat transfer characteristics of tunnel assembly **316**. Lower panel **326** may be coupled to center panel **318** by an adhesive, welding, or any other suitable method of attachment. It should be noted that inlet **330** and outlet **328** may be reversed.

Referring now to FIGS. **16** and **17**, another embodiment of a tunnel assembly is shown. Tunnel assembly **340** includes tunnel **342** which is formed by a single sheet of metal and includes side panels **346** and **348** and center panel **344**. Center panel **344** includes inlet **352** and outlet **350** which are coupled to the liquid cooling system of the snowmobile, as discussed above. Tunnel assembly **340** also includes lower panel **354**. Lower panel **354** includes channels **356** and **358**, end channel **357**, and center section **360**. Lower panel **354** is coupled to the bottom side of center panel **344** to form a heat exchanger similar to the one described above in FIGS. **14** and **15**. A cross-sectional view taken along a middle portion of the tunnel assembly **340** is shown in FIG. **18**. Additionally, a cross-sectional view taken longitudinally along the back section of tunnel assembly **340** is shown in FIG. **20**. Coolant enters inlet **352** and flows down channel **356** to end channel **357**. The coolant then flows from end channel **357** to channel **358** and to outlet **350**. Center section **360** is also coupled to the lower side of center panel **344** to separate channels **356** and **358**. Channels **356** and **358** may include a plurality of surfaces adapted to improve the heat transfer characteristics of tunnel assembly **340**. Lower panel **354** may be coupled to center panel **344** by an adhesive, welding, or any other suitable method of attachment. It should be noted that inlet **352** and outlet **350** may be reversed.

Referring now to FIG. **21**, a partial profile view of drive system **124** of endless belt assembly **12** is shown, endless belt assembly **12** includes a pair of lower rails **110**, a pair of front links **114**, and a shock absorber **120** as well as various other components (not shown). Lower rails **110** are coupled together by cross shaft **112**. Front links **114** are coupled together by cross shaft **116**. Cross shaft **116** is also coupled to shock absorber **120**. Lower rails **110** also include front tips **122**. Straps **118** are coupled to cross shafts **112** and **116** to limit the travel of lower rails **110** relative to cross bar **116**. Front and rear wheels **113** are coupled to lower rails **110**. Wheels **113** contact a portion of belt **144** between wheels **113** and lower rails **110** to maintain the proper alignment of belt **144** at it rotates around endless belt assembly **12**.

Drive system **124** includes shaft **126** which includes splined section **130** and splined section **128**. Splined section **130** receives power from the motor and transmission of snowmobile **10** to rotate shaft **126**. Splined section **128** engages sprockets **132**, **136** and **140** which engage belt **144** as shown in FIGS. **22-25**. Referring now to FIGS. **21** and **22**, sprockets **132**, **136** and **140** are positioned on shaft **126** at a position substantially in between front tips **122** of rails **110**. Sprocket **132** includes a plurality of lateral extensions **134** positioned around its outer circumference. Similarly, sprocket **140** includes a plurality of lateral extensions **142** positioned around its outer circumference. Sprockets **132** and **140** have an involute orientation. Sprocket **136** is positioned between sprocket **132** and **140** and includes a plurality of circumferentially extending projections **138**. Sprocket **136** has a convolute orientation. Shaft **126** also defines laterally extending axis **133**. Theoretical cylindrical volume **131** is defined by axis **133** and diameter **135**, which is equal to the diameter of sprocket **140**. Cylindrical volume **131** extends laterally from drive system **124**. During movement of endless belt assembly **12**, such as during a jounce event, lower rails **110** may move upward or forward to a position in which front tips **122** of lower rails **110** intersect cylindrical volume **131**. In this embodiment, drive system **124** includes three sprockets, however, any suitable number of sprockets and any suitable combination of involute and convolute orientation may be used.

Referring now to FIGS. **23** and **24**, a profile view of endless belt assembly **12** is shown. As discussed above, circumferentially extending projections **138** of sprocket **136** engage apertures **146** in belt **144**. Belt **144** also includes apertures **149**, rows of outer teeth **147** and rows of inner teeth **145**. Lateral extensions **134** and **142** of sprockets **132** and **140** engage rows of inner teeth **145** of belt **144**. Rows of outer teeth **147** of belt **144** are positioned between lower rails **110** and idler pulleys **144** to maintain belt **144** in the proper orientation. Apertures **149** permit snow and ice to contact lower rails **110** to provide cooling and lubrication.

As shown in FIG. **23**, lower rails **110** also include rear sections **148**. Rear sections **148** of lower rails **110** include upward draft **149**. In this embodiment, upward draft **149** is about three degrees, however any suitable amount of upward draft may be used on lower rails **110**. In this embodiment, rear wheels **113** are located at the point at which upward draft **149** begins, however rear wheels **113** may be located at any suitable position. Handling and ride characteristics of snowmobile **10** may improve when rear wheels **113** are positioned within one radius of the beginning of upward draft **149**. For example, if rear wheels **113** have a radius of 4 inches and upward draft **149** begins 12 inches from the end of lower rails **110**, it may be beneficial to position rear wheels **113** between 10 and 14 inches from the rear end of lower rails **110**. It should also be noted that positioning rear

wheels **113** within one radius of the beginning of upward draft **149** may improve handling characteristics of snowmobile **10** when rear idler pulleys **150** are positioned between lower rails **110** rather than on the outer surface of lower rails **110** similar to wheels **113**.

Referring now to FIG. **26**, rear sections **144** of lower rails **110** is shown. Idler pulleys **150** are positioned between lower rails **110** on cross shaft **152**. Idler pulleys **150** are positioned between plurality of inner projections **145** on belt **144** to provide the appropriate tension to belt **144** and maintain proper orientation of belt **144** during movement.

Referring now to FIGS. **27** and **28**, air intake system **152** is shown. Air intake system **152** is positioned under hood **16** of snowmobile **10**. Air intake system **152** includes air intakes **154**, ducts **156**, expandable section **158**, lower duct **164**, upper duct **176** and plenum **184**. Air inlets **154** each include screen **160** and air collector **162**. Screens **160** are positioned on hood **16** of snowmobile **10** to direct incoming air through air collectors **162** into ducts **156**. Referring to FIG. **30**, expandable section **158** is shown in the stationary position, with hood **16** in the default position, and in the raised position in phantom, with hood **16** raised.

Referring now to FIG. **29**, air from ducts **156** enters expandable section **158** which is coupled to lower duct **164**. Expandable section **158** is positioned in opening **166** of lower duct **164**. Lower duct **164** includes opening **168** and end **170**. Opening **168** supports nozzle **190** and Helmholtz box **192**. Screen **172** and resonator **174** are positioned in end **170** of lower duct **164**. Upper duct **176** couples to end **170** of lower duct **164** to enclose resonator **174** and screen **172**. Upper duct **176** includes curved portion **179** and end **180**. Curved portion **179** includes aperture **178** which includes seal **194** and Helmholtz box **196**. End **180** is coupled to seal **182** and plenum **184**. Plenum **184** includes two outlets **186** which each include seals **188**. Seals **188** are coupled to an intake manifold of the motor of snowmobile **10**. Helmholtz boxes **192** and **196** cooperate with resonator **174** to reduce the noise of incoming air. Helmholtz boxes **192** and **196** may be adapted to tune incoming air to a pre-determined frequency that is suppressed by resonator **174** to reduce the noise generated by air intake system **152**. For example, in a test snowmobile, the Helmholtz boxes and resonator were tuned to remove frequencies at 250, 500, and 750 Hertz. Helmholtz resonator's are designed and optimized by changing the volume of the plenum as well as the neck length and diameter to target a specific frequency. The frequency of attenuation of resonator **174** is a function of the whole size and spacing. Air intake system **152** includes a plurality of seals between the ducts to create a sealed system, thereby decreasing the likelihood of heating the air carried by air intake system **152** before it reaches the motor of snowmobile **10**.

Referring now to FIGS. **31** and **35**, left front ski **18** of snowmobile **10** is shown. Steering arm **223** of snowmobile **10** couples to front ski **18** at first position **208** of ski **18**. Ski **18** includes a body portion having a front end **206** and a rear end **204**. Front end **206** includes hoop **200**. The upper surface of ski **18** includes a plurality of projections **202** that are formed within the upper surface to provide traction to an operator who may stand on ski **18**. In the illustrated embodiment, a plurality of projections **202** are arranged side by side on top surfaces or top edges of longitudinally extending ribs **203**. Ribs **203** extend vertically from the upper surface of the ski **18**. Therefore, a plurality of projections **202** are arranged in longitudinally extending rows as shown in FIGS. **31** and **35**, for example. First and second outer ribs **209** and **211** are located near inner and outer edges **213** and **215**, respectively, of the ski as shown in FIG. **35**. The first and second ribs **209** and **211** each include a plurality of projections **203** arranged side by side on top edges thereof. A plurality of inner projections **203** extend upwardly from the upper surface of the ski and are located between the first and second ribs **209** and **211**. Some inner projections **203** are located on top edges of inner ribs **225** located between the first and second outer ribs **209** and **211**. Other inner projections **227** are located on the upper surface of the ski **18** between the first and second ribs **209** and **211**.

Referring now to FIGS. **32-34**, a profile and bottom side view of ski **18** is shown. The bottom surface **201** of ski **18** includes keel **212** and runner **210**. As shown in FIG. **34**, bottom surface **201** is a planar surface. Runner **210** is supported by keel **212**. Keel **212** includes front end **216** and rear end **214**. Keel **212** extends longitudinally along the bottom side of ski **18** a length L. In this embodiment, at least 60% of the length L of keel **212** is in front of (in FIG. **32**, to the left of) first position **208** which mounts to steering arm **22**. In this embodiment, the ratio of the width of the middle of keel **212** to the width of runner **210** is about 4.3, however any suitable ration may be used.

As shown in FIG. **33**, in this embodiment, rear end **214** of keel **212** is the widest portion of keel **212**. Rear end **214** is substantially wider than front end **216** or any other portion of keel **212**. In this embodiment, ski **18** is constructed of a plastic material and runner **210** is constructed of a metallic material, however any suitable material may be used to construct front ski **18** and runner **210**.

Another embodiment of a front ski that may be used on snowmobile **10** is shown in FIG. **36**. Front ski **217** may be coupled to steering arm **22** on either the left or right side of snowmobile **10**. Ski **21** includes a body portion having a front end **219**, a middle portion **220** and a rear end **218**. Outer edge **221** of ski **217** includes a laterally recessed or notched portion **222** on rear end **218** of ski **217**. In this embodiment, rear end **218** is substantially narrower than middle portion **220** of ski **217**. Notched portion **222** of edge **221** may provide superior handling in certain conditions. As shown in FIG. **36**, the ski **217** has on overall length dimension **230**. Illustratively the notched portion **222** is formed in the body portion having the planar bottom surface **201**. Notched portion **222** has a length dimension **232** which is preferably about one fifth (⅕) of the overall ski length dimension **230**. Middle portion **220** of ski **217** has a width dimension **234**. The notched portion **222** has a width dimension of **236** which is preferably about one fourth (¼) of the ski width dimension **234**. Therefore, the narrower rear end **218** of ski **217** has a width dimension **238** which is illustratively about three fourths (¾) of the overall ski width dimension **234** at the middle portion **220** of the ski **217**. This notch size balances maintaining ski floatation with the improved handling feature provided by the notched portion **222**.

The length of notched portion **222** illustrated by length dimension **232** illustrating ranges from about one sixth (⅙) to about one half (½) of the length dimension **230** of the ski **217**. As discussed above, one fifth (⅕) is the preferred length ratio. In other illustrative embodiments, the length dimension **232** is one sixth (⅙), one fourth (¼), one third (⅓) or one half (½) of the ski length dimension **230**, for example.

Likewise, the width dimension **236** of notched portion **222** illustratively ranges from about one fifth (⅕) to about one half (½) of the width dimension **234** of ski **217**. As discussed above, one fourth (¼) is the preferred width ratio.

Another embodiment of a front ski that may be used on snowmobile **10** is shown in FIG. **37**. Front ski **362** may be

coupled to steering arm **22** on either the left or right side of snowmobile **10**. Ski **362** includes front end **365**, middle portion **363** and rear end **364**. Outer edges **366** and **368** of ski **362** each include a laterally recessed or notched portion **366** and **368**, respectively, on rear end **364** of ski **362**. In this embodiment, rear end **364** is substantially narrower than middle portion **363** of ski **362**. Notched portions **366** and **368** may provide superior handling in certain conditions. As shown in FIG. **37**, the ski **362** has on overall length dimension **370**. Notched portions **366** and **368** each have a length dimension **372** which is about one fifth (⅕) of the overall ski length dimension **370**. Middle portion **363** of ski **362** has a width dimension **374**. The notched portions **366** and **368** each have a width dimension of **376** which is illustratively about one fourth (¼) of the ski width dimension **374**. Therefore, the narrower rear end **364** of ski **362** has a width dimension **378** which is illustratively about one half (½) of the overall ski width dimension **374** at the middle portion **363** of the ski **362**. The sizes of notched portions **366** and **368** may vary as discussed above with regard to notched portion **222**.

While this invention has been described as having an exemplary design, the present invention may be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains.

What is claimed is:

1. A snowmobile comprising:

a frame including side walls and a support platform, the side walls cooperating with the support platform to define a tunnel;

an endless belt assembly supported by the frame;

a motor supported by the frame;

a running board configured to be coupled with the tunnel;

a tube member positioned laterally outward from the running board and removably coupled to the running board with first removable fasteners extending into the tube member and the running board, and the side walls extend rearwardly beyond the tube member, and the tube member is removably coupled to the tunnel with second removable fasteners extending into the tube member and the tunnel, and the tube member has a forward end with a first flange and a rearward end with a second flange, and the second flange is removably coupled to one of the side walls with at least one of the second removable fasteners; and

a foot grip assembly, and a portion of the foot grip assembly is removably coupled to the first flange with third removable fasteners extending into the portion of the foot grip assembly and the first flange.

2. The snowmobile of claim **1**, wherein the foot grip assembly includes an upper member, a lower member, a toe clip, and a frame member, and the lower member is removably coupled to the running board with fourth removable fasteners extending into the lower member and the running board.

3. The snowmobile of claim **2**, wherein the toe clip extends rearwardly from the upper member, the lower member, and the frame member.

4. The snowmobile of claim **2**, wherein the first, second, third, and fourth removable fasteners each comprises a head portion and a body threaded portion extending from the head portion.

5. The snowmobile of claim **1**, further comprising a wherein the foot grip assembly is removably coupled to the running board with fourth removable fasteners extending between the foot grip assembly and the running board.

6. The snowmobile of claim **5**, wherein the foot grip assembly extends above the support platform.

7. The snowmobile of claim **1**, further comprising a plurality of upstanding members flanking the frame and the foot grip assembly is coupled to the upstanding members.

8. The snowmobile of claim **1**, wherein at least a portion of the tube member is positioned under a portion of the running board.

9. A snowmobile comprising:

a frame including side walls and a support platform, the side walls cooperating with the support platform to define a tunnel;

an endless belt assembly supported by the frame;

a motor supported by the frame;

a running board configured to be coupled with the tunnel along an inner side of the running board;

a foot grip assembly removably coupled to a forward portion of the running board assembly and the tunnel with first removable fasteners extending into the foot grip assembly and the forward portion of the running board and second removable fasteners extending into the foot grip assembly and the tunnel; and

a longitudinally-extending tube member coupled to the running board along an outer side of the running board, wherein the longitudinally-extending tube member has a forward end with a first flange and rearward end with a second flange, the first flange is removably coupled to the foot grip assembly with fourth removable fasteners extending through the first flange and the foot grip assembly and the second flange is removably coupled to the side wall with fifth removable fasteners extending through the second flange and the side wall.

10. The snowmobile of claim **9**, wherein the foot grip assembly includes an upper member, a lower member, a toe clip, and a frame member, and the lower member is removably coupled to the running board with at least one of the first removable fasteners.

11. The snowmobile of claim **10**, further comprising a steering hoop positioned at a forward end of the support platform, and the frame member is coupled to the steering hoop.

12. The snowmobile of claim **10**, wherein an upper end of the upper member is removably coupled to the frame member with third removable fasteners extending into the upper end of the upper member and the frame member.

13. The snowmobile of claim **12**, wherein the first, second, and third removable fasteners each comprises a head portion and a body portion extending from the head portion.

14. The snowmobile of claim **9**, wherein the longitudinally-extending tube member is removably coupled to the running board with sixth removable fasteners extending into the longitudinally-extending tube member and the running board.

15. The snowmobile of claim **14**, wherein the sixth removable fasteners each comprises a head portion and a body portion extending from the head portion.

16. The snowmobile of claim **9**, further comprising an air intake system operably coupled to the motor and adapted to supply air to the motor, the air intake system including a Helmholtz box.

17. The snowmobile of claim 9, wherein the fourth and fifth removable fasteners each comprises a head portion and a body portion extending from the head portion.

* * * * *